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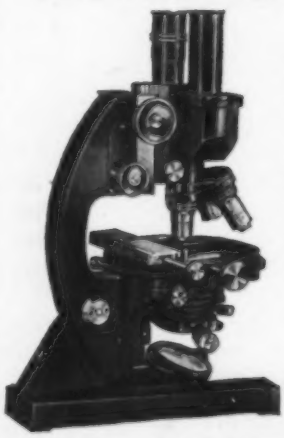

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Overcrowded Professions

AN 'unemployment' problem which has for years baffled university and State authorities in many countries and has, in some, assumed an aspect of tragic intensity for the individuals immediately concerned and of menace for the community, is dealt with by Prof. W. M. Kotschnig in a valuable survey of the subject recently published*. It is scarcely too much to say that the magnitude of the problem is not yet fully appreciated. Here, in Great Britain, where unemployment of university graduates has been on a relatively small scale, although it has given rise to some anxiety in the case of the teaching profession, it has not been 'in the news', but it has been the subject of intermittent investigation and discussion since 1930, and a series of precautionary and preventive measures were suggested at last year's congress of the National Union of Students. The consideration of any such suggestions will be greatly facilitated by reference to Prof. Kotschnig's lucid account of the conditions of the problem and of solutions attempted in various countries, and his comments, criticisms, and suggestions which are evidently the fruit of close observation and long study. In his "Planless Education", published in 1935, he gave a preliminary report of the results of the world-wide survey of the situation undertaken in 1932 by International Student Service, Geneva, of which he was formerly general secretary. For the present volume, that report has been revised, brought up to date, amplified, and developed.

The main theme—unemployment of university graduates—is introduced by an account of the actual situation in each of twenty-two countries and this is followed by an estimate of causes and effects. The situation is blackest in Austria and Hungary, where the overcrowding of the professions is described as complete and absolute. "In Germany, the 40,000 or 50,000 workless university graduates in 1931–33 became, together with unemployed subalterns of the old Imperial army, the spearhead of the National-Socialist movement." There is, as yet, no other country in the world with such tens of thousands of unemployed graduates, "but there are many countries which are not far from the danger point".

The social problems created by the surplus of university graduates have created "countermeasures", to which Prof. Kotschnig devotes particular attention. A discussion of numerical restriction, the *numerus clausus*, leads on to a consideration of the German law of April 1933, which had the effect of reducing admissions by a half. This drastic limitation of numbers was accompanied by a change in the quality of entrants, due to the introduction of new criteria of selection : race, sex, character, and national reliability (*nationale zuverlassigkeit*), sincerity of outlook (*lauterheit der gesinnung*), bodily prowess, and capacity for comradeship and devotion. This accords with the new conception of the university, introduced with the Nazi regime, as existing for the advancement, not of knowledge in general or of the education of the individual, but of the National-Socialist State. Simultaneously, there was a ruthless elimination from the professions of Jews and others obnoxious on account of their political opinions or affinities. By this rough surgery the urge for higher education (or its diplomas) was checked, and overcrowding relieved.

* "Unemployment in the Learned Professions : an International Study of Occupational and Educational Planning." By Prof. Walter M. Kotschnig. Pp. xii+348. (London : Oxford University Press, 1937.) 12s. 6d. net.

Upon the subject of occupational and educational planning Prof. Kotschnig insists, with perhaps exaggerated emphasis, on the irresistible, "almost elemental" strength of the modern urge for education (most of which might, perhaps, be more justly called "urge for diplomas"), as evidenced by statistical tables. The forces manifesting themselves in this urge—craving for a fuller life, desire for the better pay and social standing to which academic qualifications lead, and faith in the power of knowledge—these forces, far from being played out, are, in many countries, gaining momentum as progress is made towards educational emancipation of the "under-privileged". In Germany this historical trend has been arrested. Under the National-Socialist regime, educational planning has there involved drastic restriction of educational opportunities, and a solution of the problem of overcrowded professions has been reached as part and parcel of a reactionary movement which scorns academic freedom, has little use for the ideal of equal educational opportunity, and has resuscitated the warrior ideal—"a nation of soldiers" (Dr. Goebbels). Elsewhere, such a solution will not, in Prof. Kotschnig's opinion, prove acceptable, and it is suggested that a more excellent way—or, rather, ways, for diversity of conditions in different countries forbid the application of a general prescription.

It is especially in the field of secondary education that replanning is indicated. Except in Italy, where, as a result of Gentile's reorganization of 1923, half of the secondary education is now vocational, there has been a wholly inadequate adjustment in this field to changing social needs. It is pointed out that, in communities where the process of mechanization of industry has been most highly developed, the great majority of young people leaving secondary schools must enter occupations which do not call for any prolonged vocational training, but rather for a well-trained mind and adaptability. Hence the ruling aim of the ordinary secondary school in such communities should be "an education broad enough to fit them not only for work, but for an intelligent and creative use of their leisure time, a training enabling them to be active members of an enlightened citizenry". There should be, in addition, schools of two special types for those pupils whose special aptitudes mark them out for a career (1) in the professions, or (2) as highly skilled craftsmen or technicians. It is suggested that such a clarification of aims and differentiation of types of secondary schools should lead to an improvement in quality of their product so great that the social prestige and equipment for life of the secondary school graduate would approximate to those of the ordinary university graduate.

Palæolithic Age in Palestine

The Stone Age of Mount Carmel:
Excavations at the Wady el-Mughara. By D. A. E. Garrod and D. M. A. Bate. (Report of the Joint Expedition of the British School of Archæology in Jerusalem and the American School of Prehistoric Research, 1929–1934.) Vol. 1. Pp. xii + 240 + 55 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1937.) 42*s*. net.

THE foreword by G. Grant MacCurdy to the work under notice recalls that, after the discovery of a fragment of Neanderthaloid skull in Galilee (1925), and the International Archæological Congress at Jerusalem (1926), he had the pleasure in 1928 of following the excavations of Miss Garrod at Shukbah, Wady en-Natuf, 27 kilometres north-west of Jerusalem. He mentions Miss Garrod's fine excavations at Gibraltar a short time before, in which she had found a skull of Neanderthal type. Then came her successful expedition to Iraq (1928) and, finally, in 1929, her excavations, for the joint expedition mentioned in the title above, at Wady el-Mughara in the coastal zone near Haifa, where she was ably assisted by T. D. McCown.

No fewer than eighteen societies and institutions, six of which were British, contributed to the considerable expenses of the expedition, and the great quantity of archæological material obtained was distributed amongst forty museums or institutes. In 1932, for reasons of health, Miss Garrod had to hand over the direction of the excavations to Mr. T. D. McCown, who later gave all his time to the preparation of various Neanderthaloid skeletons found just then by him.

The palæontological classification was undertaken by Miss D. Bate, and the study of the anthropological remains still goes on at the Royal College of Surgeons and will be described in future volumes.

The excavations were prosecuted successively in three neighbouring caves, rich in deposits, in the hilly valley on the slopes of Mount Carmel, on the left of the "valley of the caves", Wady el-Mughara, just where it debouches on the coastal plain. Mughara-el-Wad was first excavated, then Mugharet-es-Skhūl and finally Et-Tabūn, in which deposits nearly 20 metres deep exceeded those of both the previous caves. In a series of chapters describing the stratigraphy and archæology of the sites, Miss D. Garrod, and, for Mugharet-es-Skhūl, Mr. McCown, tell of the results obtained. Needless to say that while congratulating the authors on their excellent and sober descriptions, we cannot give a detailed account of these, but pass immediately to their conclusions (chap. viii), where we learn that in the three sites, not counting superficial deposits of Bronze Age or more recent date, there are twelve archæological and palæontological levels graded in exact sequence, which can, if preferred, be reduced to ten. The oldest are found only at et-Tabūn, where the enormous deposits stretch from the Tayacian to the Upper Levalloiso-Mousterian, whilst Mugharet-es-Skhūl was only occupied from the Lower-Levalloiso-Mousterian, and Mugharet-el-Wad begins in the Upper Levalloiso-Mousterian, but possesses three Aurignacian levels, one Atlitian and two Natufian.

Such an important sequence tells the whole human history of the Palestinian district and also agrees with the partial results obtained by other excavators, such as R. Neuville and M. Stekelis in the Judean desert. It also makes possible a comparative study of former excavations. Still this work does not classify the earlier industries, such as those in the open-air sites, like the Abbevillian of El Beka (Jerusalem) and others which are old Acheulean and primitive Levalloisian in the Beyrouth region. The lowest level contains a flake industry (Tabūn *G*) resembling the French Tayacian in its chipping technique of an oblique striking platform, and its position which underlies the final Acheulean, where there are no associated bones. This is confirmed by the discoveries of R. Neuville at Oum Qatafa.

Above (Tabūn *F* and *E*) there is a very fine Upper and Final Acheulean (Micoquian) already known at ez-Zuttiyeh (Galilee), where it was mixed with the Levalloiso-Mousterian, and at Oum Qatafa, etc. There are always a certain number of flakes with prepared striking platforms, more frequent near the top, and various types of scrapers, gravers with Audi or Châtelperron points, tools appearing at a later date in Europe.

Then the very long Levalloiso-Mousterian cycle begins, divided into levels *D*, *C*, *B*, at Tabūn, *F*2 and *G* at El Wad, *B* and *C* at es-Skhūl with slight morphological variations in this already evolved industry (such as the proportion of points and side-scrapers, the diminution from bottom to top in the number of axes, the presence of gravers and scrapers) all of too technical an interest for this short review, as is their comparison with those in the various excavations of R. Neuville, the ones at Shukba and those made by Zumoffen. In the course of development of this industry, important changes of fauna are noticeable—the disappearance of big pachyderms and the increase of Cervidæ. It was during this period that a tribe of Neanderthaloid men lived in the Wady-el-Mugharet. Of these, Miss Garrod has found one specimen at Tabūn in level *C*, and some fragments.

Mr. McCown found quite a cemetery of Neanderthaloid individuals. His account of their discovery in the narrow space of about 9 × 4 metres, of the measures taken for collecting them and determining their position, and the photographs and drawings which recorded these, form a deeply interesting whole, doing great honour to Miss Garrod's devoted fellow-worker.

At El-Wad, the lower Aurignacian rests on the Upper Levalloiso-Mousterian, with which it is mingled as at Mugharet-el-Emireh, but Neuville found it pure at Jebelqafseh. There are Châtelperron points and another type called El-Emireh, typical of that Palestinian level; it is a triangular point with base reduced by bi-facial trimming. The different types of gravers (angle, polyhedric, beaked, etc.) exist, though there are not many; but blunt backed blades are abundant.

Then, towards El-Wad, there are two mid-Aurignacian levels. The yet lower level noted by Neuville at Irq-el-Ahmar and Jebelqafseh, distinguished by the presence of blunt backed points, nose scrapers and beaked gravers, and the absence of El-Emireh and Font-Yves points, is lacking here.

Most of the known Western types of flints are found, but, except that their working improves, especially in level *D*2 of El-Wad, where there are a good many fragments of blades with broad marginal trimming and more nose scrapers than there are lower down, there are fewer gravers, though of the same types—angle, ordinary, polyhedric, beaked, flat, etc. But points of Font-Yves type with a sharp point and nibbled edges are only found in lower levels. No bone industry is mentioned.

Similar industries at Nahr-el-Kelb and Antelias (Beyrouth) have long been known, and Neuville found them at Irq-el-Ahmar and El Khiam.

Level *C* of El-Wad, which follows, Miss Garrod calls Atlitian to avoid the question of connexions with the African industry, instead of Capsian as she first called it; it is also not definitely Upper Aurignacian. What characterizes this level is the

great number of Châtelperron points and a mass of polyhedric gravers. For the first time here, we note two pierced shells. At El Khiam there is a related industry.

It only remains for me to discuss the very important Natoufian level crowning the Palæolithic series. A hiatus exists here at its base, filled up at El Kebarah by the special microlithic industry found there by Mr. Turville Petre under the lower Natoufian. This "Kebaran" is distinguished by long narrow microlithic blades, with blunted backs and sharp or obliquely chopped points, associated with small gravers and scrapers. At El Kebarah, the Lower Natoufian was rich in sculptured and worked bones (T. Petre), as in different sites of the Judean desert (R. Neuville). The latter divided the Natoufian into four levels of which I, II and IV are found more or less at El-Wad; IV is the level with notched arrowheads.

At El-Wad, level *B*2 (lower Natoufian) is extraordinarily rich in the geometric types of tool; lunates are distinctive of Helouan (Egypt) with triangles, rather rarer trapezes and a good many micro-gravers. There are blades with chopped ends and blunted backs meant to be hafted in series as sickle-blades, and many kinds of gravers and scrapers, thick rods or 'fabricators', and a kind of pick. Most of these types are also in the Upper Natoufian, but with the notched arrowheads of Helouan forming a link with the Mesolithic of Lower Egypt.

Natoufian bone tools, although less rich than the stock at El-Kebarah (T. Petre), include a good many bone points or awls, polishers, etc.; besides some fragments of very simple harpoons, the most important are sickle-hafted with a deep groove to insert sickle-blades, such as those at Helouan, some of which have been found fixed. A very pretty sculpture of a young deer-like animal was found in 1928 by Mr. Lambert in a sounding and is probably part of a sickle-handle. A second sculpture, a small human head in stone, is very rough.

It is perhaps the dawn of agricultural conditions, which is revealed in the Natoufian by the discovery of pieces of pestles and mortars in basalt and limestone, sometimes coloured with ochre, decorated with moulding, and ending sometimes in an animal's hoof. Still more remarkable is the terrace, suggestive of a place of primitive worship, quite clearly lower Natoufian in date, with a quantity of deeply hollowed basins on a ledge 1·5 metres × 2 metres, encircled with a rim, surrounded by remains of a flat stone kerb, and near a dry stone wall 8·5 metres long, the lower half made of single blocks 0·50–0·70 metre in diameter. This place, probably used for religious ceremonies, was also the centre of a great number of burials (forty); fourteen were in perfect preservation. Another group in the centre of the first room showed three layers of bodies, one on the other, stretched out and lying on their backs (ten in all). Those on the terrace differed by being flexed. Five of them had very elaborate personal ornaments, illustrated here by splendid photographs, crowns made of dentalium, cleverly arranged lengthwise, cross-wise and in fan-shapes. They had necklaces too, made of dentalium, alternating with 'twin' pendants, which seem to me to imitate the canines of deer, with distal segments cut from gazelle phalanges, or from the tarsian tibia of birds, sometimes notched.

I suppose the skeletons and their very remarkable personal decorations will be more extensively discussed, when the time comes for the detailed description of the bones.

The second part of the volume is devoted to the study, by Miss Bate, of the fauna; in spite of its great merit, it is too technical to be discussed at length. We must confine ourselves to confirming what this distinguished palæontologist says, namely, that the Upper Acheulean *F* level contains a good many extinct species, suggesting damp tropical conditions. Dry conditions prevail in Acheulean *E* and lower Levalloisian *D*, where *Hippopotamus* and *Rhinoceros hemitechus* are still found.

The rainy phase occurs at the end of *C* (mid-Levalloiso-Mousterian) in which the number of big bovines increase greatly. In *B* (Upper Levalloiso-Mousterian) we reach an extremely wet but not very warm phase, producing a very marked change of fauna, the big pachyderms definitely disappearing. During the Aurignacian, the climate grew warmer, but became—except for a slight increase in humidity in the middle—drier and drier until the end of the Natoufian; gazelles increase as the deer diminish. In the Natoufian, the domestic dog appears.

L. Picard considers that a minor damp period should be inserted just before the Bronze Age. In spite of the temptation felt to correlate the succession of wet and dry periods with the Western glacial stages of Riss and Würm, which seems to me fairly likely, Miss Garrod awaits discoveries in open-air sites, and especially those near the coast, before announcing her opinion.

Such are, much abbreviated, the fine results obtained by Miss D. Garrod and her fellow-workers during their six years work at Wady el-Mugharet. Thanks to her, and to the allied excavations of R. Neuville, Turville Petre, etc., the Palæolithic stage in the Palestinian caves is one of the best known in the world to-day, and for this we congratulate her.

H. BREUIL.

Science and Philosophy

Philosophy and the Physicists
By Prof. L. Susan Stebbing. Pp. xvi + 295. (London: Methuen & Co., Ltd., 1937.) 7*s.* 6*d.* net.

THE relations between science and philosophy have assumed a new aspect in this generation. The remarkable developments of physics, which have called for a reconsideration of certain fundamental concepts, have made it, if not impossible, at least highly undesirable, for these two departments of thought to maintain the attitude of superior indifference with which labourers in each have sought to conceal their incapacity for the work of the other. The physicist, if he is to avoid the slough of metaphysics which lies close to his new scene of operations, must learn to recognize its characteristics; and the philosopher, seeing his categories overrun by barbarians, is forced to fight the invaders with their own weapons, in the use of which he is unskilled. An interesting situation is thus created, which, it is to be hoped, will develop into better understanding and more friendly relations.

If we have succeeded in what may be the impossible task of taking an impartial view of the matter, we may say that the most essential fact is that modern physics has something vital to say to philosophy. It has brought to light principles of general philosophical import, by means of which a vast amount of apparently unrelated experience has been fused into a connected rational system with the power of extensive, if not unlimited, growth. Whatever their shortcomings may be, those physicists who have tried to interpret the new work in philosophical terms are aware of this. They behold the light, even if they are somewhat confused about whence it flows, and the vision splendid is to be seen by those who read between their lines. There is little evidence, however, that philosophers in general have caught a glimpse of it. The only philosophy (except, perhaps, that of Prof. Whitehead, which bears a relation to modern science that is still somewhat obscure) which takes explicit account of the principles animating modern physics seems to be logical positivism, which, in spite of certain merits, is a sorry enough creed. A few years ago, Mr. C. E. M. Joad published a book entitled "Philosophical Aspects of Modern Science" which, so far as it bore any relation to modern science, was concerned only with the unphilosophical aspects of modern physicists. Even Prof. Stebbing, fairest of critics, misses this primary fact of the situation. How otherwise can we account for the sweeping statement on p. 283—"Every scientist turned philosopher tends to find support in his special studies for the metaphysical theory which *on other grounds* he finds attractive"—when only four pages earlier she has said of her chief victim, "It is indeed clear that this is the change [the change in the status assigned to physical laws] that gave to Eddington's conception of the physical world that 'idealistic tinge' which was entirely different from the complexion of his earlier philosophical views"?

On the other hand, the philosopher may justly claim that physicists should present their findings in language which he can understand. It is unfair to expect him to become a physicist or to exchange logical habits of thought for cheap emotionalism. If the physicist claims to have found something important for philosophy and wishes philosophers to understand it, he should enter their courts as a guest, and honour the obligations appertaining to that dignity. Though he may not be prepared to make philosophy his pattern, he should be willing to live for a while in her mild and magnificent eye and learn her great language. It cannot be denied that physicists are not above reproach in this matter. When Sir James Jeans, for example, claims that on fundamental problems science must speak before philosophy, and assumes the role of spokesman with the comment that although not a philosopher either by training or by inclination, he has the better view of the game proverbially granted to the onlooker, he invites Prof. Stebbing's acid retort that the proverb applies only to those who know the rules observed by the players. There is certainly room for a better appreciation of philosophical problems, and a wider knowledge of the attempts already made to solve them, on the part of those physicists who cry the merits of their own particular nostrums.

It is this right of the philosopher (or, rather, of "the common reader", for it is as such that she somewhat too modestly claims to speak) that Prof. Stebbing asserts, and she supports her case by subjecting the works of Sir James Jeans and Sir Arthur Eddington to a minute analysis. Other writers receive occasional attention, and there is some independent discussion of abstract problems, but it is clear that Jeans and Eddington are "the physicists" and that the main purpose of the book is to show how far they are from being philosophers and how far removed from intelligibility are their writings. Jeans's work is too crowded with inconsistencies for any clear idea to emerge, and

Eddington not only is so anxious to write pure poetry that he forgets that some of his readers would like to know what he means, but also is so fascinated by the products of his imagination as to be unable to form a consistent philosophy for himself. These theses Prof. Stebbing seeks to establish in terms which, with respect to both purport and temper, are unexceptionable. She is severe but never spiteful, and she has the faculty of expressing cardinal points in a sentence. For example—"Jeans makes no effort to explain how it is that the Great Mathematician should have turned aside from his mathematical activities and condescended to create the world"; and again—"The problem that confronts Eddington is to get as much uncertainty, or 'indeterminacy', as he can out of the miserably small amount represented by Planck's constant."

How far Prof. Stebbing establishes her case the reader must be left to judge. Two tempting but superficial criticisms may, however, be forestalled. The first is that in dissecting Eddington's parables and allegories she is revealing insensitivity to their character and producing something equivalent to a logical analysis of one of Blake's lyrics. This would be a fair criticism if the process were not necessitated by Eddington's own method. The attempt to find the flaw in his more closely reasoned passages leads inevitably to an idea first introduced playfully in an anecdote and thereafter treated as though it had been logically established. Consequently there is no alternative to breaking the butterfly on the wheel.

The second criticism that might be made is that the book is too much occupied with the splitting of hairs. It is true that some fine distinctions are made, though most of the 'hairs', alas, are only too rope-like. Hair-splitting, however, is a process quite properly indulged in by specialists in every field, and it appears pedantic only when practised by others. Physicists are more expert at the process than most. It was hair-splitting that discovered the noble gases, and no philosopher has yet split a hair so fine as that severed by the statement that the law of gravitation is not precisely that of the inverse square, yet the resulting strand has to bear the weight of all modern theories of the universe. When the fundamental problems of human existence are in question, therefore, it can scarcely be held superfluous to isolate the less than a hair that perchance divides the false and true.

The problems aroused by the book have more than academic importance. We have been told, for example, that more than 100,000 copies of "The Mysterious Universe" have been sold. The number that have been understood is precisely nil, if, as Prof. Stebbing suggests, the book is essentially unintelligible. What process, then, went on in the minds of many readers to produce an illusion of understanding and lead to the dissemination of its phrases from pulpit, press and platform? The implications of that question call for serious consideration by those interested in the future of democracy.

H. D.

The Science of Radio Engineering

Radio Engineering
By Prof. Frederick Emmons Terman. Pp. xiii + 813. (New York and London: McGraw-Hill Book Co., Inc., 1937.) 30*s*.

A CERTAIN ruthlessness is inevitable in any text-book, and the permissible coefficient of ruthlessness is higher in engineering than in physics. Yet there is room for doubt whether a book on radio engineering which does not once mention the names of such founders as Clerk Maxwell, Popoff, Marconi, Jackson, Oliver Lodge, Larmor and Eccles does not fall below that level of piety which may fairly be demanded of even the 'toughest guy' in applied science. It is also to be doubted whether a book in which the first chapter, on the "Elements of a System of Radio Communication", is so ruthlessly shorn of qualifications, limitations and explicit cautions about implicit assumptions and simplifications is safe reading, even for engineers. The spiritual danger is obvious, but that there is much practical danger is well illustrated in such things as the misapplication of the "Rayleigh-Carson reciprocal theorem", a sharp-edged tool which is of great value in sufficiently subtle hands, but which produces strange shapes from the hand of the ruthless.

Despite such blemishes, the first edition of Terman's "Radio Engineering" established itself, rightly, in the first rank of guides to the transformation of radio engineering from an empirical and only roughly quantitative art into a logical and closely calculated science. The second edition, almost wholly re-written and very generously illustrated, will be of still greater value and will be welcomed by the great army of industrious 'Termanites' on both sides of the Atlantic—and of the Pacific.

The work, as the author's preface points out, falls into two parts. The first, dealing in 500 pages with fundamental properties, has chapters on circuit constants, properties of resonant circuits, vacuum tubes, vacuum-tube amplifiers, power amplifiers, vacuum-tube oscillators, modulation, vacuum-tube detectors and sources of power for operating vacuum tubes. The second part, devoting nearly 300 pages to more specialized radio topics, covers radio transmitters, radio receivers, propagation of waves, antennæ, radio aids to navigation, television, sound and sound equipment. It is far from adverse criticism to say that the whole forms a connected and reasoned guide to the last ten years' issues (up to a remarkably recent date) of the *Proceedings of the Institute of Radio Engineers*, to which the reader is, in copious and well-chosen footnotes, referred for fuller information. That air of intellectual nationalism which results from the natural tendency of an American teacher to refer American students mainly to American books and periodicals is not very offensively marked for the British reader, but the German, French and Dutch contributions to radio engineering are severely attenuated by the band-pass filter of an assumed unilingualism.

The first part of the book, on circuits and their components, is clearly the author's own territory, and is extremely good and comprehensive, with considerable tracts of original work which will be valuable to all radio engineers. The second part, and particularly the chapters on propagation of waves and on radio aids to navigation, are much less satisfactory, mainly because the light and shade of these subjects lend themselves badly to that sharp black and white treatment which so notably smooths the student's way through circuit work.

Prof. Terman's second edition will enhance the high reputation gained by his first, and should be at the right hand of every radio engineer. His half-tone blockmaker has invariably, and his line draughtsman not infrequently, served him ill, but the book is otherwise very pleasant to handle.

A New Guide to the Organic Molecular World

Dictionary of Organic Compounds: the Constitution and Physical and Chemical Properties of the Principal Carbon Compounds and their Derivatives, together with the Relevant Literature References. Edited by Prof. I. M. Heilbron and H. M. Bunbury. Vol. 3: Naphthacarbazole—Zygadenine. Pp. xii+943. (London: Eyre and Spottiswoode (Publishers) Ltd., 1937). £6 6*s*. net.

THE appearance of this volume completes the production of the first dictionary of organic compounds in the English language. The high standard of the first two volumes (NATURE, **134**, 751, Nov. 17, 1934; **137**, 342, Feb. 29, 1936) has been maintained, and the whole work has been published within a period of three years. This is a truly remarkable achievement, in which all concerned may take a pardonable pride. More than that, the publication of such a work by a team of British chemists speaks volumes for the wonderful progress which organic chemistry and biochemistry have made in Great Britain during the past twenty years.

Only those whose duties call for daily references to the vast and complicated literature of organic chemistry can realize to the full the great service which Prof. Heilbron and his collaborators have rendered to the *Fachgenossen*. Here is a work of some 2500 pages, printed in beautifully clear type, occupying less than 7½ inches of shelf-space, self-indexing, and affording thoroughly up-to-date information concerning the great majority of important organic compounds: a magic casement looking out upon that boundless organic molecular world "whose margin fades for ever and for ever when we move".

Even the unremitting expansion of this organic universe is to be followed, although not (we are glad to notice) by the issue of an indefinite succession of supplementary volumes. The editors propose to adopt a more practical and time-saving method for keeping a work of this nature up to date, by issuing revised volumes at regular intervals, beginning probably in 1939. Thus the three-volume format will be a recurring characteristic of the "Dictionary", which will also, of course, remain as a self-indexing entity.

Prof. Heilbron, Mr. Bunbury, their growing team of skilful and enthusiastic collaborators, and their publishers, deserve the thanks of all workers in organic chemistry and biochemistry for this elegant agent, which will catalyse so effectively the future labours of the fraternity.

JOHN READ.

Genetics and the Origin of Species

By Prof. Theodosius Dobzhansky. (Columbia Biological Series, No. 11.) Pp. xvi+364. (New York: Columbia University Press; London: Oxford University Press, 1937.) 18*s*. net.

THIS well-designed and lucidly written book by one of the foremost younger geneticists is a thoughtful contribution to the problem of the origin of species. Not only does the author bring forward a clear and balanced statement of the genetical viewpoint, but he also supplies an exposition of recent genetical, cytological and statistical work in a form which is easily assimilated by the non-specialist.

The author divides his subject into (1) changes in the individual, (2) changes in the population, (3) fixation of these changes. Under the first heading are discussed gene and chromosome mutations, and the relation between evidence from the laboratory and that found in the wild. Under the second, a lucid description of the work of Wright, Fisher and Haldane leads to an estimation of the relative importance of selection, population size and variability in evolution. Under fixation of changes the author gives an extended account of polyploidy, hybrid sterility and other forms of isolation. The concluding chapter contains several pertinent remarks on the status of species.

The reassessment of old theories in the light of the experimental evidence is performed with a caution and soundness which will repel only those who are dogmatic upholders of tradition.

This is probably the best recent book for students who have an elementary knowledge of Mendelism, mitosis and meiosis, and who desire to understand the genetical evidence and viewpoints in biological questions. F. W. S.

Appendix to the Four Volumes of the "Mysore Tribes and Castes" (Index and Bibliography)

By Diwan Bahadur Dr. L. K. Ananthakrishna Iyer. Pp. iv+70. (Mysore: Mysore University, 1936.)

AN ethnographical gazetteer loses half its value if it lacks an index; but the appendix which the late Dr. Ananthakrishna Iyer had added to the four volumes of his "Mysore Tribes and Castes" makes an even more generous provision for the needs of the student. In addition to index and bibliography, his supplementary volume includes a glossary of vernacular terms, and lists of endogamous groups and exogamous clans. Attention is directed to the evidence to be found in these lists of the tendency of endogamous groups to increase, notwithstanding attempts made to bring about union, and the disappearance of totems in favour of gotras of Puranic heroes.

The bibliography would be of much value to students if it were not for numerous errors and omissions of detail due to insufficient preparation and indifferent proof-reading, for which Dr. Ananthakrishna Iyer, who died in February 1937, is probably not responsible. As it stands, it is of little use to anyone who cannot identify many of the references from previous knowledge of anthropological literature.

Manual on Research and Reports:

a Guidebook of Procedures helpful in conducting Investigations and presenting Reports on Subjects in the Fields of the Social Sciences. By the Committee on Research of the Amos Tuck School of Administration and Finance, Dartmouth College. Pp. x+140. (New York and London: McGraw-Hill Book Co., Inc., 1937.) 7*s*. 6*d*.

THE steady stream of complaints, of which that by Dr. G. W. C. Kaye in his presidential address to Section A at the British Association meeting in Nottingham is only one of the most recent, regarding the deficiency of science graduates in writing reports and the ability to express themselves in concise and lucid English, has already called forth a number of books intended to correct this defect.

The present manual forms an admirable addition to this literature. It is concise and well written, and although designed primarily for those concerned with economic or social research, the chapters on preparing the manuscript and the anatomy of a report, as well as on guarding against error, and submission to a printer or publisher, can be read with profit by most scientific workers, whether engaged in academic or in industrial research. Many of the points may be seen to be matters largely of common sense, but experience suggests that the careful and thoughtful reading of the chapters on the collection of first-hand information, recording and organizing information, analysis and interpretation of data will well repay most recruits to scientific and industrial research.

Useful, however, as this manual is likely to prove, it is little credit to our educational system that such literature as this should still be meeting a definite need.

Einführung in die Physik

Von Dr. Otto Blüh. Pp. xvi+582. (Berlin: Gebrüder Borntraeger, 1937.) 16 gold marks.

DR. BLUH has written an introduction to physical science which is a valuable contribution to the literature of the subject. His book represents roughly that part of the content of physics which may be assumed to be the property of a well-prepared student for a general honours degree or of a student revising the preliminary stages of his reading for special honours. No topics of serious importance are omitted and the main thesis is developed logically and clearly through some 500 pages, from the first section on "Masse und Messen" to the end of the concluding section of the second part on "Klassische Physik und Quantenphysik". A third part of the volume, some 30 pages in length, is devoted to the subject of the extent and significance of physical knowledge.

Descriptions of physical instruments are terse, clear and confined to essentials; the mathematical arguments are of an elementary kind, involving at most one or two simple differentiations and integrations, and the balance is well kept between the different main sections of physics.

The book will provide good practice for a student anxious to obtain fluency in reading German. A. F.

Nuclear Physics and Medicine

Modern High-Voltage Equipment in the United States and on the Continent of Europe

By L. G. Grimmett, Radium Beam Therapy Research, London*

MANY interesting developments in radiology may be expected during the next few years, as a consequence of the discovery of the neutron and of artificial radioactivity.

The neutron has peculiar and novel properties which may make it of particular value in radiation therapy. To mention only two: it is more heavily absorbed in the hydrogenous tissues of the body than in the bones, and it ionizes by means of recoil protons which give densely ionized tracks, in striking contrast to the characteristics of X- and gamma-radiation, where absorption is roughly proportional to the density of the absorbing medium, and ionization proceeds by means of thinly ionized recoil electron tracks. For these reasons alone it might be anticipated that neutrons would produce different biological effects from X-rays. Indeed, the preliminary experiments of Lawrence and his collaborators on the effects of intense neutron beams on wheat seedlings, mouse tumours and other living organisms, indicate that neutrons are more effective biologically than X-rays, and what is perhaps more significant for therapeutical purposes, that they have a greater 'selective action' than X-rays; that is to say, they inflict relatively greater damage on malignant cells than on normal ones.

Artificial radio-elements have already proved their worth as chemical and biological indicators. Elements can be 'labelled' by mixing with them a small quantity of a radioactive isotope, and their subsequent history traced through the most complicated chemical actions by means of the associated radioactivity. In this way, for example, the metabolism of calcium and phosphorus in the body of the rat have been studied.

Now that it is becoming possible to produce short-lived radioactive isotopes of the common elements in large quantities, measurable in millicuries, we may hope to extend the scope of chemotherapy by the use of radioactive organic compounds, the therapeutic action of which would depend on their radioactivity rather than on their chemical properties.

The recent advances in pure physics are thus of considerable interest to medical science, and I was glad, therefore, to have had the opportunity, through the generosity of the Prophit Trust of the Royal College of Surgeons, of visiting many institutions abroad to see what progress had been made in this kind of work. My impressions are given below; it is only possible in this short article to summarize the chief points of interest.

* Published by permission of the Executive Committee of the Radium Beam Therapy Research, London.

Production of Intense Neutron Beams and of Radio-elements

The methods commonly employed for producing intense neutron beams are the bombardment of deuterium, beryllium or lithium by swift deuterons, the probable reactions being:

1. $^{2}_{1}D + {}^{2}_{1}D \rightarrow {}^{3}_{2}He + {}^{1}_{0}n$
2. $^{9}_{4}Be + {}^{2}_{1}D \rightarrow {}^{10}_{5}B + {}^{1}_{0}n$
3. $\begin{cases} {}^{7}_{3}Li + {}^{2}_{1}D \rightarrow {}^{8}_{4}Be + {}^{1}_{0}n \\ {}^{7}_{3}Li + {}^{2}_{1}D \rightarrow 2{}^{4}_{2}He + {}^{1}_{0}n \end{cases}$

The efficiency of the last three reactions increases rapidly with the speed of the impinging deuterons.

Neutrons are also liberated in large numbers when beryllium is bombarded with gamma rays of energy greater than 1·4 million volts.

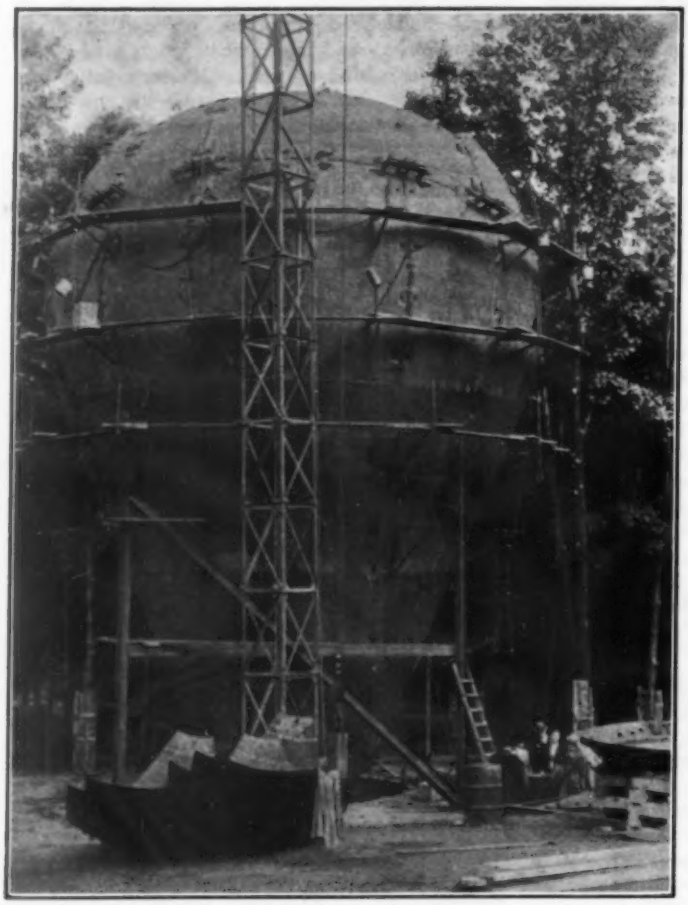
Radio-elements can be synthesized in a great variety of ways, by bombarding elements with neutrons, protons, deuterons or helium nuclei. Here again, the neutron method apart, the efficiency of most reactions increases rapidly with the energy of the bombarding particles. It is essential, therefore, to have means of accelerating light nuclei by potentials of the order 1–5 million volts.

The chief types of apparatus for producing high-energy particles are:

1. *Cascade transformer.* This was one of the earliest types of high-voltage generators, developed by Lauritsen at Pasadena in 1928 for X-ray production at 750 kilovolts, and extended later to 1 million volts. The greatest voltage which has been reached anywhere by this method is about 2 million. The apparatus is large and costly and requires a special building to house it. Currents up to 30 milliamperes can easily be obtained, but they are alternating, which is a disadvantage for many purposes. It is doubtful whether any more cascaded transformers will be built for nuclear physics, in view of the rapid developments of alternative methods.

2. *The cyclotron.* The cyclotron of Lawrence accelerates light nuclei to very high speeds by multiple accelerations through a small potential of 20,000 volts or so. Two *D*-shaped electrodes, fed with high-frequency alternating current, are placed in a strong magnetic field which causes the particles to curve back repeatedly through the accelerating field. In this way protons and deuterons can attain speeds corresponding to 5 million volts and more. Using ion currents less than 100 microamperes, the cyclotron has furnished the most powerful neutron beams yet obtained, with which most of the biological work to date has been carried out. Its size is remarkably small for its performance; the whole apparatus, complete with high-frequency oscillator for supplying the electrodes, can be placed in a room of modest dimensions. The power consumption is heavy, about 30 kilowatts being required for the electromagnet and 70 kilowatts for the oscillator. The magnet may weigh as much as 100 tons. The cost is high, and a skilled staff is required to run it.

The cyclotron is not, of course, suitable for accelerating electrons for X-ray production. There are about 25 cyclotrons being built in the world: two of them are in England (Cambridge and Liverpool), intended primarily for physics research.



THE 5 MILLION VOLT ELECTROSTATIC GENERATOR OF THE CARNEGIE INSTITUTION, WASHINGTON, D.C., IN COURSE OF CONSTRUCTION (SEPTEMBER 1937). The charging belts and ion accelerating tube will be mounted vertically inside the pear-shaped tank 55 feet high by 37½ feet in diameter, and worked under an air pressure of 50 lb./sq. in. The target and observation room are underground for protection purposes. (By kind permission of the Director.)

3. *Electrostatic generator.* Through the efforts of numerous workers in the United States, the old-fashioned electrostatic generator of the Holtz type has been revived and developed into a formidable high-voltage generator. A well-insulated hollow conductor is charged by swiftly moving endless belts of silk or rubber on which electric charges have been sprayed by corona discharge from a set of points kept at a potential of 10,000–20,000 volts. The voltage attainable is limited only by the breakdown of the surrounding air or by sparking along the insulators, the current being proportional to the size, number and speed of the charging belts. A large generator of this kind has been installed at the Massachusetts Institute of Technology, developing 5 million volts (one terminal 2·5 million volts positive, the other 2·5 million volts negative, to earth) and a current of 2 milliamperes.

A great advance was made by Herb, Parkinson and Kerst, of Madison University, Wisconsin, who enclosed an electrostatic generator together with an ion accelerating tube in an earthed steel tank, and worked them under an air pressure of 100 lb./sq. in. By this means, the breakdown voltage was increased to nearly four times its value at atmospheric pressure and a steady voltage was obtained of 2·1 millions to earth in a tank 20 ft. long by 6 ft. in diameter. Naturally, in this form the apparatus is independent of the humidity of the external air.

The design of this and other high-voltage machines is likely to be influenced by the discovery of the remarkable insulating properties of the gas CCl_2F_2, known commercially as a refrigerant under the name "freeon". The breakdown voltage of freeon is two to three times greater than air, and by using this gas under pressure it is possible to increase the breakdown voltage by a factor of 10.

Tuve, of the Carnegie Institution of Washington, D.C., is building a large electrostatic generator working in compressed air (see accompanying illustration). It is expected that voltages in excess of 5 millions will be obtained. The target of the ion tube is at earth potential and is underground, for protection purposes.

The electrostatic generator is relatively cheap, simple and robust. It is beginning to be adopted for hospital use; the Huntingdon Memorial Hospital, Boston, has installed one to work an X-ray tube at 1·2 million volts, 3 milliamperes.

4. *Resonance generator.* So far this ingenious apparatus, due to Sloan, has only been applied to X-ray production. Insulation difficulties are avoided by hanging a copper coil from one end in an evacuated earthed steel tank, about 4 ft. across, and making it resonate with a 100 kilowatt radio-frequency oscillator mounted above it, but not connected to it. High-frequency oscillations are induced in the coil, and an alternating potential of about 1 million volts is developed at the free end of the coil, which carries a target. The target faces a hot filament in the wall of the tank, which is biased so that electrons are accelerated only during the peak values of the alternating voltage. The apparatus is compact, but the power consumption is great (100 kilowatts). There is one of these generators in San Francisco, and another at Columbia University, New York.

5. *Cascade generators (voltage multipliers).* Greinacher, Cockcroft and Walton, and Bouwers, developed independently the cascade generator, an arrangement of condensers and rectifying valves by means of which an alternating potential of 200 kilovolts or so may be multiplied many times and rectified.

Bouwers has succeeded in getting 1·5 million volts constant potential to earth by this method at Philips' Laboratories, Eindhoven, and contemplates 2 million volts to earth in the near future.

The apparatus is on the large side and is expensive, but can be bought ready for use, and certainly has an impressive performance. It is independent of climatic conditions, has an ample reserve of power, and costs little to run.

At the moment, no ion tube is available at Eindhoven which will stand up to these voltages, but Bouwers, Heyn and Kuntke have constructed ion tubes to work at 300 and 600 kilovolts, yielding more than 1 milliampere of positive ion current, giving neutrons equivalent to 100 gm. of radium and beryllium. Even this, however, is a rather small neutron output for biological work, and some of the biological results obtained with it were criticized at the Fifth International Congress of Radiology (Chicago 1937), on these grounds.

Prof. P. Debye is installing a Siemens cascade generator in the new Kaiser Wilhelm Institute at Dahlem, for studying the materialization of gamma rays; it is in two halves, each giving 1·4 million volts to earth, with a total of 2·8 millions between the ends.

6. *Impulse generators.* Impulse generators working up to 2 million volts have been used for a long time in electrical engineering for the testing of transformers and insulators. The method consists of charging a number of condensers in parallel to 50,000 volts or so, and then discharging them in series, when a momentary voltage equal to the sum of voltages of the separate condensers is obtained. The apparatus is usually quite big and necessitates a special building, the output is under imperfect control, and is not suitable for exact physical experiments. Prof. F. Joliot, however, has turned it to good account in the manufacture of artificial radio-elements. At the Laboratoire Ampère, Paris, he has an impulse generator capable of giving 3 million volts, which is applied to an oil-immersed multi-sectioned X-ray tube of the Brasch and Lange type, about 1¼ metres long. The target of the tube is surrounded by beryllium. The heavy bursts of X-rays which occur at each impulse liberate photo-neutrons from the beryllium, which activate elements placed near by. Quantities of radio-elements approaching a millicurie have been obtained in this manner, and it is hoped to increase the yield by improving the tube design.

Incidentally, Prof. Joliot has solved the difficult problem of selecting the best apparatus for nuclear physics by installing one of each! His new Laboratory of Nuclear Physics, Paris, which is nearing completion, will have at its disposal a cyclotron, cascade generator, 2 million volt cascade transformer, 5 million volt electrostatic generator (recently a popular spectacle at the Palais de la Découverte of the Paris Exposition 1937) together with the impulse generator just mentioned. An extensive scheme of biological research is being planned in collaboration with the Radium Institute of Paris.

High-voltage X-ray equipment. X-ray apparatus for therapeutical purposes is still being developed towards higher and higher voltages, in the belief that the shorter wave-lengths are superior in their biological effects. There is a welcome tendency

towards reducing the dimensions of the equipment. Bouwers described at the Congress of Radiology a million-volt installation, with sealed-off X-ray tube, measuring only 10 ft. × 8 ft. × 6 ft. high.

When the voltage has been pushed a little higher we shall be within sight of an efficient substitute for the natural gamma rays of radium (the radiation spectrum of which extends to about 2 million volts), at a price within the reach of the smaller hospitals, which cannot afford to buy large quantities of radium.

The main impression left by this tour is of the vigour with which the new physical knowledge is being followed up abroad, and applied to biology. One cannot but be struck with the absence of similar efforts in Great Britain, where, apart from a 400 kilovolt neutron generator which is being built at Mount Vernon Hospital, Middlesex, and the 1 million volt X-ray plant at St. Bartholomew's Hospital, London, no work of this kind is going on at all.

It is to be deplored that there is no institution in England where these important physico-medical problems can be attacked with the thoroughness they deserve.

Resonance and Mesomerism

By Prof. C. K. Ingold, F.R.S.

MESOMERISM is an extension of valency theory, and, like all valency theory, is founded in the quantum theory.

It may be recalled that in the quantum theory it is shown to be impossible accurately to specify the position and motion of an electron at each instant of time. What can be known about an electron, considered as a particle, is of a statistical nature, and is summarized in the behaviour of a wave. The frequency of the wave measures the energy of the electron ($E = h\nu$) and the amplitude measures the probability that the electron is in a given elementary volume (prob. = $|\psi|^2 dv$). The fundamental wave-property in the theory of the *atom* is *self-interference*—the self-interference of a confined wave; this annihilates all frequencies except those that can form standing waves, which are perpetuated and describe the quantum states. The fundamental wave-property in the theory of *valency* is *resonance*—the resonance of connected standing waves; their mutual perturbation replaces these waves by new standing waves, one of which usually corresponds to the creation or modification of some bond.

In order to appreciate the significance of resonance in the theory of valency, it is useful to recall the nature of resonance in vibrating mechanical systems. The simplest example is that of two like pendulums hung from the same stretched string. If one pendulum is given a displacement, its interaction with the string causes the vibratory motion gradually to become transferred to the second pendulum, after which it travels back to the first (Fig. 1). This motion is obviously not simple harmonic, but it can be shown to be a mixture of two simple harmonic motions. One of these occurs alone if we start the pendulums with equal amplitudes in phase; the frequency $\nu - \varepsilon$ is then a little less than the frequency ν of either uncoupled pendulum, because the two pendulums when swinging in phase deform the supporting string in mutually accommodating ways and this lowers the restoring forces. The other simple harmonic motion occurs when we start the pendulums with equal amplitudes in opposite phase; the frequency $\nu + \varepsilon$ is now a little greater than that of the uncoupled pendulums because of the opposing actions on the string. When we start the pendulums with any arbitrary amplitudes and phase difference, the two simple harmonic motions occur together, and the 'beats' arising from their differing frequencies give rise to the complicated motion described.

If ψ_1 and ψ_2 are the co-ordinates measuring the displacements of the two pendulums, then before coupling, each co-ordinate was associated with a definite frequency ν, but after coupling neither co-ordinate has any definite frequency. On the other hand, the linear combination $\psi_1 + \psi_2$ has the frequency $\nu - \varepsilon$, whilst the combination $\psi_1 - \psi_2$ has frequency $\nu + \varepsilon$. We may say that the mutual perturbation or 'resonance' has replaced the former co-ordinates of periodic motion (ψ_1 and ψ_2) by two independent linear combinations ($\psi_1 + \psi_2$ and $\psi_1 - \psi_2$), and has split the original coincident frequency (ν) into two frequencies, one greater and one less than the original.

In Fig. 1, (*A*) represents the uncoupled equivalent pendulums. Their displacement co-ordinates are ψ_1 and ψ_2, and their motion is periodic, each pendulum having the frequency ν. (*B*) and (*C*)

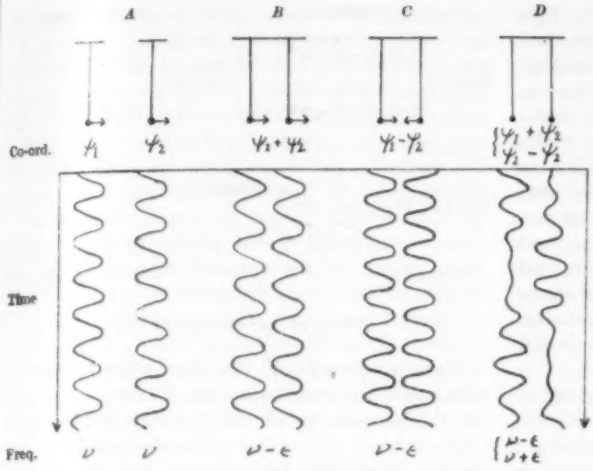


Fig. 1.

MECHANICAL RESONANCE: TIME-GRAPHS ILLUSTRATING THE BEHAVIOUR OF UNCOUPLED AND COUPLED PENDULUMS.

illustrate the only two sets of conditions in which the pendulums, when coupled, can undergo singly periodic motion. In mode (*B*) the pendulums are started with equal amplitudes in phase, and they then keep in phase; the displacement co-ordinate of the coupled system is thus $\psi_1 + \psi_2$. As the time-graph shows, the period is a little longer, and therefore the frequency, $\nu - \epsilon$, is a little smaller, than for a single uncoupled pendulum. For mode (*C*) the pendulums must be started with equal amplitudes in opposite phase; they then remain in opposite phase, and accordingly the displacement co-ordinate is $\psi_1 - \psi_2$. As illustrated in the time-graph, the period is shorter, and the frequency, $\nu + \epsilon$, greater, than for a single uncoupled pendulum. (*D*) represents the general result of coupling, the amplitudes and phase difference at the commencement of motion being arbitrary. Simple periodicity now disappears, but the motion can be represented as a superimposition of the periodic motions separately represented in (*B*) and (*C*). On account of the small frequency differences produced by the coupling, the superposition of these periodic motions causes the beat-like alterations of amplitude illustrated in the time-graph. Thus the general effect of the coupling is to replace two identical periodic motions by two other periodic motions, one of increased and one of decreased frequency.

If there are alternative ways in which we can supply electrons to a fixed system of atomic nuclei, and if the standing waves representing these alternatives can perturb each other, then there will be resonance. The simplest example is that of the hydrogen molecule-ion, H_2^+. There are obviously two ways of supplying an electron to a system of two hydrogen nuclei, which at first may be supposed to be fixed too far apart to admit of appreciable interaction (Fig. 2). If the electron is put near nucleus *A*, it will move in a manner represented by the standing wave ψ_A; if it is placed near nucleus *B*, it will move according to the standing wave ψ_B. The frequency of each wave corresponds to the energy of a hydrogen atom, and the form determines the probability, or charge-cloud, distribution. If now the nuclei are moved closer together so that the fringes of ψ_A and ψ_B overlap, each wave will perturb the other and neither will any longer be a standing wave of characteristic frequency. Two new standing waves will arise; one, the like-phase combination, $\psi_A + \psi_B$, which has a decreased frequency, and the other, the opposite-phase combination, $\psi_A - \psi_B$, which has an increased frequency. The former represents a system of reduced energy, a more 'stable' system, and corresponds to the formation of a bond.

Referring to Fig. 2, we have: (1) Separate ψ-waves, ψ_A and ψ_B, of identical frequency, ν, formed by supplying the electron to either of two well-separated, identical nuclei. (2) On moving the nuclei closer together the ψ-waves overlap and thus destroy each other's simple periodicity. This mutual interference, or 'coupling', gives rise to resonance, the periodic components

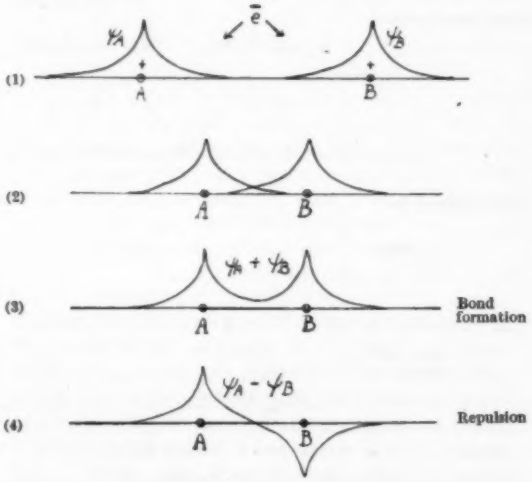


Fig. 2.

QUANTUM MECHANICAL RESONANCE: SCHEMATIC REPRESENTATION OF THE FORMATION OF A ONE-ELECTRON BOND.

of which are illustrated in (3) and (4). (3) This 'like-phase' periodic combination wave (displacement co-ordinate $\psi_A + \psi_B$) has a frequency, $\nu - \varepsilon$, smaller than the frequency, ν, of the uncoupled waves ψ_A and ψ_B. The system represented thus has reduced energy: it is the molecule, which the atoms will therefore combine to form. (4) In this 'unlike-phase' combination (displacement co-ordinate $\psi_A - \psi_B$) the frequency, $\nu + \varepsilon$, is greater than the frequency ν of ψ_A and ψ_B. This system has an increased energy, and represents a state from which the separated atoms will be regenerated. (In all the diagrams normalization is neglected, that is, the vertical scale is left arbitrary.)

This is the wave-picture: a particle-picture of the same phenomenon may be drawn as follows. It is a direct consequence of the uncertainty principle that all particles of which the motion is restricted have vibrational energy. The uncertainty principle may be written $\Delta q . \Delta p \simeq$ Planck's constant h, where Δq represents the uncertainty in the position of the particle and Δp the uncertainty in its momentum; the momentum is, of course, closely related to the kinetic energy. A particle which is confined to a very small region of space ($\Delta q \to 0$) would vibrate with a correspondingly large energy ($\Delta p \to \infty$); and in proportion as the region is expanded the energy of the particle will be reduced. By moving nuclei A and B closer together we allowed an electron, originally imprisoned in the region of ψ_A, to escape into the region of ψ_B, and this expansion of domain, in accordance with the uncertainty principle, is accompanied by a decrease of electronic energy.

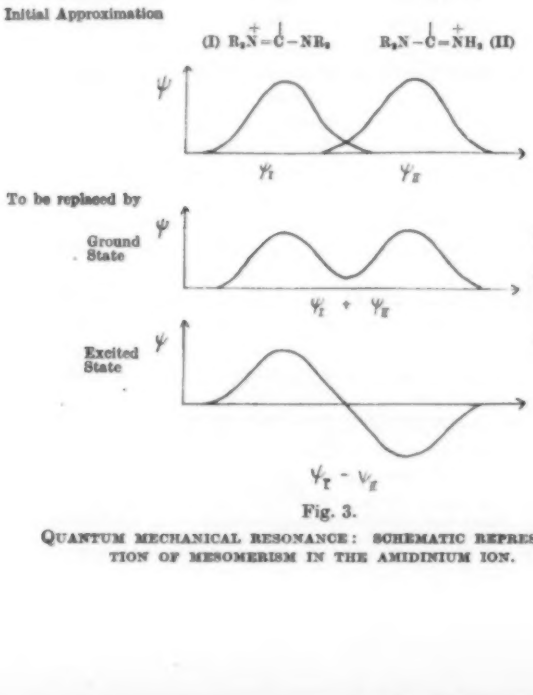


Fig. 3.

QUANTUM MECHANICAL RESONANCE: SCHEMATIC REPRESENTATION OF MESOMERISM IN THE AMIDINIUM ION.

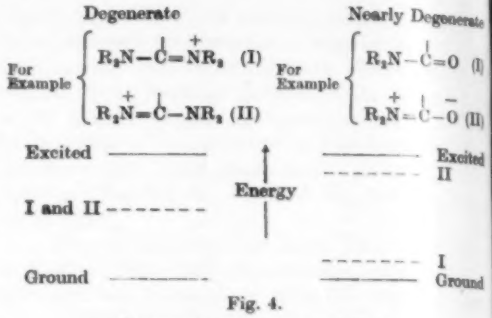


Fig. 4.

SPLITTING OF ENERGY LEVELS.

These are essentially the ideas which, variously elaborated and combined with the Pauli principle, are fundamental to all valency theory. The one-electron bond, the ordinary two-electron bond, the double bond, the triple bond, van der Waals' forces, steric repulsion—all involve resonance. It is true that wave-forms describing the statistics of poly-electronic systems are difficult to represent geometrically, but we can understand, through the analogy of the one-electron case, how resonance may lead to situations of increased stability. Leaving aside, however, all these intermediate chapters in the large subject of valency theory, we must here pass from the simple one-electron bond directly to that particular case of resonance which, on account of its special importance in organic chemistry, has received a special name, namely, mesomerism.

We can regard an ordinary structural formula as a symbol of the standing wave which has been derived by taking into account all the resonance involved in the bonds of the formula, and selecting from the final linear combinations of wave-functions that which has lowest energy. Mesomerism arises when, with nuclei in fixed positions, we can write several ordinary structural formulæ; for in this case the corresponding 'final' combination waves are not really final. They have to be linearly combined once more, with a further delocalization of the electrons, and a further gain in stability. It is essentially as a matter of convenience rather than principle that we separate this final stage of approximation to a true description from the previous stages, these being summarized in the classical structural ideas which the conception of mesomerism attempts to improve.

As an example we may consider the amidinium ion. The standing waves corresponding to the alternative formulæ are similar; strictly expressed they are polydimensional, but are here represented (Fig. 3) schematically in one dimension. The final combination wave is a mixture of equal proportions of the two, and hence the charge-cloud distribution may be described as intermediate between those corresponding to the alternative formulæ. The identical energy levels represented by the alternative formulæ are, as usual, split into a ground level which lies lower, and an excited level which lies higher, than the original coincident levels (Fig. 4). We usually speak of the ground state as "the" mesomeric state, and the energy interval between this state and that of the structural formulæ as the energy of mesomerism.

Method 1.

Mesomeric between

$$R_2N-CR=O \text{ and } R_2\overset{+}{N}=CR-\overset{-}{O}$$

Method 2.

$$R_2N-CR=O$$

Method 3.

$$R_2N-CR-O$$

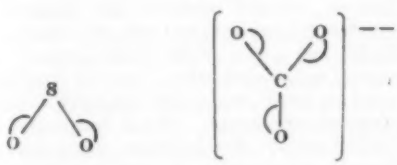


Fig. 5.

EXAMPLES OF NOTATION.

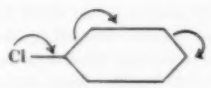
When the alternative formulæ are dissimilar, as in the amide group, there will be upper and lower initial energy levels, and the corresponding waves will not mix together in equal proportions. The combination wave of the ground state will contain an excess of the lower initial wave and that of the excited state an excess of the upper. But still the ground level will lie below the lower of the initial levels, and the charge-cloud will be intermediate between those of the initial structures.

There are several ways of expressing the intermediate character of the electron distribution in a mesomeric system. One way is to write down the various 'paper-formulæ' and to add a statement that the real formula is a mean between them (Fig. 5). A second is to write one paper-formula and attach curved arrows to it to show the direction in which it requires to be corrected. A third is to introduce a curved bond sign for each non-localized electron pair. The method chosen will depend on the example and the point which it is desired to emphasize. For example, the neatest method of expressing the trigonal symmetry of the carbonate ion is the third.

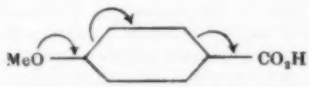
When mesomerism was first recognized (1926) as a general phenomenon in organic chemistry, it was appreciated as an electron displacement rather than as an energy disappearance: one might say that the mixing of the ψ's was perceived before the splitting of the ν's. This was because mesomerism was the electronic successor to Flurscheim's "quantitative effect", which, as he himself said, must represent a permanent redistribution of valency because it had to do with chemical equilibria, and therefore with the normal undisturbed states of molecular systems.

At that time very little was known about molecular dipole moments, but the dipole moment test for mesomeric electron displacement has since been carried out, chiefly by Sutton. He has shown that although Coulombic induction produces dipole moments in unsaturated compounds as in saturated, the former in general exhibit an extra moment, which is clearly due to mesomerism, since it always has the direction which could either have been anticipated from theory or deduced from the organic chemical observations*.

The energy disappearance characteristic of mesomerism, and its cause in electron-delocalization—the resonance of structures—was appreciated only after the fact of the polarization had been known for some years (1929). We have only to consider, however, that mesomeric polarizations, such as we can detect in chlorobenzene by dipole moments,



or in *p*-anisic acid by the acid-strengths,



in each case oppose the Coulombic induction of the substituent (Cl or MeO, both electron-attractors), in order to realize that the energy-drop which drives the polarization forward, and gives extra stability to the polarized system, must be large and independent of Coulombic energy; therefore it must come from the only other possible source, namely, the resonance energy.

* More exact evaluations of the extra moment have recently been made by Sugden.

Concerning the physical evidence of the energy disappearance, it is widely known that Pauling and Sherman collected together a large body of thermochemical data which showed that the resonance energy is always negative, and may vary from quite small values up to several electron volts. The most successful attempts to calculate the energy effect of mesomerism are those of Pauling and Wheland.

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Obituary Notices

Prof. G. H. F. Nuttall, F.R.S.

DR. GEORGE HENRY FALKINER NUTTALL, emeritus professor of biology in the University of Cambridge, died suddenly in London on December 16 at the age of seventy-five years.

Nuttall was born in San Francisco, where his father practised as a medical man; but later the family moved to Europe and Nuttall received his early education in England, France, Germany and Switzerland, and it was thus that he laid the foundations of his linguistic attainments. Later, Nuttall returned to the University of California, where he graduated M.D. in 1884. After a brief period at the Johns Hopkins University, he studied at Breslau and Göttingen, where he remained for four years and obtained the degree of Ph.D. At this time he became interested in botany and zoology, and these subjects led him on to the study of parasitology, to which he devoted the greater part of his life. On his return to Baltimore in 1890, he became assistant to the late Prof. Welch and later associate in hygiene at the Johns Hopkins University. In 1893 Nuttall returned to Germany and joined the Hygienic Institute of Berlin, acting as honorary assistant to Prof. Rubner. He married in 1895, Paula, daughter of Kammerherr von Oertzen-Kittendorf, Mecklenburg.

In 1899 Nuttall went to Cambridge to teach bacteriology and preventive medicine, and in the following year he was appointed University lecturer in these subjects, receiving the honorary M.A. degree. In 1906 he was appointed reader in hygiene, obtained the degree of Sc.D. and was elected a fellow of Christ's College. He held the office of reader for a few days only, being elected to the newly established Quick professorship of biology and to a professorial fellowship of Magdalene College. In 1907 the Quick Department moved into a large room on the ground floor of the east wing of the Medical School. Here in these uncomfortable quarters, which were divided up into alcoves by means of cupboards and screens, and which were known as the Quick Laboratory, Nuttall worked until 1920. In 1919, generous benefactions amounting to £30,000 from the late Mr. and Mrs. P. A. Molteno provided for the erection of the Molteno Institute for Research in Parasitology.

Nuttall received many honours; in 1904 he was elected a fellow of the Royal Society, at the same time as his friend Shipley. He also received honorary degrees from several universities. He was awarded the Belgian Order of Leopold II and the French distinction of Commandeur de la Légion d'Honneur.

Nuttall's research, incorporated in more than two hundred published papers and books, covers several branches of biology, including bacteriology, serology, hygiene, tropical medicine and parasitology. His outstanding achievement was the discovery that the blood and other body fluids possess bactericidal power, a discovery which laid the foundations of all work on serum antitoxins. In 1904 he published his classical monograph "Blood Immunity and Blood Relationship", incorporating the results of an extensive investigation of precipitin reactions carried out on some six hundred species of animal's blood. This investigation has clearly demonstrated the existence of a distinct similarity in chemical structure of the blood in animals which are related phylogenetically. It opened a new way of studying the phylogenetic relationships in the animal kingdom and provided also a new method for identification of the origin of minute traces of blood, a method which has had notable application in forensic medicine. In collaboration with Thierfelder (1895–97) he carried out the first successful experiment on life under aseptic conditions. In these investigations, guinea pigs delivered by Cæsarian section were kept alive and fed under bacteria-free conditions. These experiments solved one of the outstanding problems which preoccupied Pasteur and his pupils, and also demonstrated the origin of some organic substances in the gut and urine of animals. In collaboration with Welch (1892), he discovered and studied the first pathogenic gas-producing micro-organism causing the "gas-gangrene". This work, which came into prominence only during and after the Great War, opened a new chapter in bacteriology.

Nuttall's work on mosquitos comprises the first distribution map of *Anopheles maculipennis* in England and the discovery that this distribution coincides with the past and present distribution of

malaria (ague) in England. This was followed by an important study of the biology and anatomy of *A. maculipennis*, carried out in collaboration with the late Sir Arthur Shipley. His study of canine piroplasmosis represents the first attempt of investigation in Europe of a disease imported by means of an infected vector—a tick—from South Africa. An important result of this investigation, which has great economic importance, was the discovery of the curative property of trypan blue for piroplasmosis in dogs, cattle and sheep. This study was followed by an extensive investigation of the anatomy, biology, life-history and systematics of ticks carried out in collaboration with Mr. C. Warburton, Dr. L. E. Robinson and others. Most of his time during and after the Great War was given to the study of lice (*Pediculus*), their life-history, biology and anatomy, and the problems connected with the methods of combating the spread of these parasites.

In 1901 Nuttall founded the *Journal of Hygiene* and in 1908 *Parasitology*, both of which he edited with great distinction, setting up a very high standard of publication in this field of biology. During his tenure of the Quick professorship, he raised £60,000, which was expended on building, endowment, and research, and received grants for research workers totalling nearly £12,000. On his retirement in 1932, he was presented by his colleagues and pupils with his portrait in oils painted by his friend, the late Philip de Laszló.

Nuttall had a charming manner and was a great conversationalist and excellent *raconteur*. One has a vivid recollection of him on a hot day last summer, distinguished, indefatigable and ever courteous, leading a number of French scientific investigators round the colleges and retailing in fluent French, anecdotes and stories from his apparently inexhaustible store of knowledge. He was always at ease in whatever company he found himself and had the knack of putting his companions at ease also. He was never at a loss for the right word or a courteous reply. At international gatherings he was always surrounded by numerous colleagues and was greatly helped in such company by his extensive travels and by his ability readily to speak so many languages. In spite of his multifarious activities, Nuttall found time to collect the photographs of many of the most famous parasitologists and biologists of the past, and this unique collection now adorns the walls of the corridors in the Molteno Institute. During his travels in the course of this long and active scientific career, Nuttall had exceptional opportunities of establishing contact, usually developing into friendship, with many distinguished workers of international reputation. He knew intimately several of them and had friendly scientific correspondence with others.

Nuttall's death deprives us of one of the last links with what may be described as the heroic periods in the history of bacteriology and tropical medicine. Nuttall died suddenly, as he always hoped to die, with his enthusiasm and energy little impaired and free from disabilities and sufferings often associated with old age. His wife died in 1922. He is survived by two sons and one daughter. D. K.

Capt. H. W. Seton-Karr

WE regret to record the death of Capt. H. W. Seton-Karr, archæologist, explorer and big-game hunter, who died on January 12 at the age of seventy-eight years.

Heywood Walter Seton-Karr, a member of an old Scottish family, was the son of George Berkeley Seton-Karr, resident commissioner of Baroda during the Indian Mutiny. Born in 1859, he was educated at Eton and went up to Oriel College, Oxford, afterwards entering the army. During the Egyptian campaign of the early 'eighties he served in the 92nd Regiment (afterwards the Gordon Highlanders), for which he received the medal, clasp and Khedive's star. He then travelled extensively in Egypt and Somaliland, making a large collection of palæolithic stone implements; these were among the first of extra-European origin to be recognized, and were afterwards described in the *Journal of the Anthropological Institute*. Later he made collections of similar stone implements in India. An assiduous collector, he is said to have presented collections of stone implements gathered on his travels to more than two hundred museums in various countries. In pursuit of big game he made no fewer than thirty-nine expeditions to Africa, India and Arctic Europe. He was an expert painter in water-colours and was commissioned to paint for the Imperial War Museum. His published works included "Shores and Alps of Alaska", "Ten Years' Wild Sport in Foreign Lands" and "Bear Hunting in the White Mountains".

WE regret to announce that the promising young Danish physicist Fritz Kalckar died suddenly from heart-failure a few weeks ago. Although only twenty-seven years of age, he was already one of the most brilliant collaborators of the Institute of Theoretical Physics, Copenhagen, and had written a number of interesting papers on various atomic problems. Only a few months before his death he published with Prof. Bohr, in the communications of the Copenhagen Academy, a paper on the recent development of the theory of nuclear reactions, which was intended as the first part of a series of papers on this subject.

WE regret to announce the following deaths:

Mr. H. L. Heath, formerly principal of the Mayo School of Arts and Crafts, and curator of the Lahore Museum, on February 10, aged sixty-six years.

Sir Truby King, director of child welfare, Dominion of New Zealand, 1921–27, and author of well-known standard works on the feeding and care of young children and on mothercraft, on February 9, aged seventy-nine years.

Dr. Charles Lallemand, formerly Inspecteur général des Mines, France, and president of the International Union of Geodesy and Geophysics in 1919–33, on February 1, aged eighty years.

Dr. John K. Small, director of research and curator of the New York Botanical Garden, known for his work on the flora of the United States, on January 20, aged sixty-eight years.

News and Views

Prof. Alexander McKenzie, F.R.S.

AT the end of the current session, Prof. Alexander McKenzie will retire from the chair of chemistry in University College, Dundee, which he has occupied with distinction for the past twenty-four years. After graduating in the University of St. Andrews, McKenzie began his chemical research work with Purdie at St. Andrews, and later took his degree of Ph.D. under Marckwald at Berlin. Before succeeding the late Prof. Hugh Marshall in his original university, in 1914, he held appointments as lecturer in chemistry in the University of Birmingham (1902–5) and head of the Chemistry Department at Birkbeck College, London (1905–13). In the University of St. Andrews, McKenzie has achieved a great reputation as a stimulating teacher and director of research, besides rendering valuable services over a long period as a member of Court and Senatus. McKenzie's researches in stereochemistry have earned him a well-merited international recognition as a leading authority in a branch of chemistry which has expanded so remarkably since he carried out his early researches in this field with Marckwald. He has maintained his original interest in the fundamental problems of asymmetric synthesis, and his name will always be associated with elegant work on these problems, as well as on the Walden inversion, and on the migration of organic radicals. His isolation (with Wren in 1908) of optically active benzoin may be cited as a particularly delicate stereochemical achievement, typical of his work in general. McKenzie is also known as a master in the application of the Grignard reagent and a pioneer in the vast field which was opened up by the addition of this invaluable new weapon to the armoury of organic chemistry. He will carry with him on the occasion of his retirement the cordial good wishes of his numerous circle of friends, both in Great Britain and abroad.

Sir Arthur Keith, F.R.S.

To commemorate his term of office as conservator of the Museum of the Royal College of Surgeons of England for twenty-five years, Sir Arthur Keith was presented on February 14 with a bronze bust of himself which had been made by Miss Kathleen Parbury. The bust was purchased by a large number of Sir Arthur Keith's friends and old pupils. Sir Cuthbert Wallace, in making the presentation, referred to the fundamental work of Sir Arthur Keith on the anatomy of the transmitting system of the heart and to his contributions to anthropological science during the past thirty-five years, and, in asking Sir Arthur to accept the bust, expressed the affection which all those who had subscribed, and many others, felt towards him. In his reply, Sir Arthur thanked his friends and old pupils for their generous gift, and asked the President of the College to accept the bust for safe keeping in the College Museum. After the presentation, Sir Arthur delivered a lecture on the prehistoric peoples of Palestine, the substance of which is published elsewhere in this issue.

Planning Scientific Research in Great Britain

To the January number of the *Nineteenth Century and After*, Prof. J. D. Bernal contributes an article entitled "A Policy for Scientific Research for Britain". The article is based on a memorandum on the same subject which was drawn up for the Parliamentary Science Committee by a joint committee of the British Science Guild and the Association of Scientific Workers. This memorandum was the subject of the leading article on research and finance published in NATURE of July 11, 1936. Some modifications have been made in the original memorandum, as the result of criticisms or suggestions by various individuals and scientific associations. Prof. Bernal makes an estimate of what he calls "the present budget of science in England". He arrives at a mean figure of £4,500,000, which represents only one tenth of one per cent of the national income—contrasting very unfavourably with the millions spent on advertising. In the United States the annual expenditure on scientific research is approximately £40,000,000, representing three tenths per cent of the national income or relatively three times as much as the British expenditure. Prof. Bernal puts the expenditure in the Soviet Union as only just under one per cent, and says that in Germany and in Japan it is probable that the proportional sum spent is between three and five times that of Great Britain.

IT is claimed that the present system of financing research in Great Britain does not meet the requirements of the situation and that a bolder and more comprehensive scheme is needed. The proposals of the Parliamentary Science Committee are, briefly, to form a permanent endowment fund for science, so as to ensure simultaneously: (1) adequate finance provided regularly; (2) a suitable rate of increase of income; (3) a comprehensive scheme of research covering all and not only part of the industries of the country; and (4) an organization co-ordinating the work of the different scientific departments and institutes. For these purposes, it is proposed to form a National Scientific Research Fund under the control of a Scientific Research Endowment Board, which would be an autonomous authority of the same type as the Electricity Board or the B.B.C. The Fund is to be provided jointly by the Government and industry, the Government contribution being by means of block grants from the Treasury over a number of years; and the contributions of the

industrial firms might, it is suggested, take the shape of some kind of voluntary levy. One of the earliest tasks of the Board would be the planning of scientific research on a comprehensive scale. Research associations could be increased to cover all industries and might be grouped under research boards, following the example of the present Iron and Steel Research Board. In addition, it is suggested that a number of institutes for studying the fundamental aspects of applied research might be set up. It is not claimed that this proposed scheme for the endowment of science is more than a first draft, and the publication of the present proposals is intended in the first place to stimulate discussion, from which it may be hoped alternative, better balanced and more comprehensive schemes might emerge.

Drift of the Soviet Polar Station

DURING the last week, the drift of the Soviet Polar Station has become more rapid and on several days was as much as thirty miles. On February 11 the station was in lat. 71° 48′ N., long. 19° 52′ W., and within sight of the coast of East Greenland. *The Times* reports that the Danish authorities have sent instructions to Danes and Eskimos at the settlement at Scoresby Sound to arrange food depots along the coast in case the Russians decide that the only possible retreat is to cross the ice stream to the land. The men are now living in a snow hut, but so long as the ice stream remains compact they are in no immediate danger. Their greatest risk lies in the probability of the pack spreading and the floes being dispersed and destroyed farther south. Moreover, the southern part of East Greenland is very rugged and has no inhabitants or food depots south of Angmagsalite. If the men have to cross the ice stream to land, it is unlikely that they will be able to carry much with them. The icebreaker *Yermak* left Leningrad on February 11 and should be off the east coast about February 19. She has on board an autogyroplane, by which it is hoped a landing on a floe of restricted size will be possible. The last reports available were to the effect that the *Taimir* and the *Murman* are in constant telephonic communication with the men, but that a storm on February 14 had prevented an aerodrome being formed on the ice from which an aeroplane might start to rescue them.

Experimental Flights Across the Atlantic

THE recent successful separation in the air of the seaplane *Mercury* from the flying boat *Maia* directs attention to the experimental work upon the matter of long-distance flights with commercial aircraft that is proceeding in readiness for the resumption of the Atlantic crossings during the coming summer. This combination, known as the Mayo Composite or "Pickaback" aircraft, built by Messrs. Short Bros. of Rochester, is an attempt to get a seaplane into the air with a wing loading that is prohibitively high for normal take-off, but is practicable for flight when once in the air at a safe height. The upper component is a heavily loaded seaplane that carries out the actual flight. This is carried on top of a comparatively lightly loaded flying boat capable of taking off and climbing easily and safely. When at about 5,000 feet the two separate, parting rapidly in a vertical plane, without risk of fouling or subsequent collision. Another method of attacking this problem is for the machine to start with a minimum of fuel, then sufficiently lightly loaded for safe take-off, and take on its full load of petrol from a tanker aircraft while in the air. Messrs. Imperial Airways, in co-operation with Sir Alan Cobham, have been using one of the large Empire class flying boats, the *Cambria*, for tests upon this method, with satisfactory results so far as they have gone.

A THIRD method is to catapult the machine into the air, giving it the necessary minimum forward speed for flight by applying an impulse to it by some exterior mechanism, using hydraulic or explosive power. This, while possibly the simplest, is the least comfortable for the occupants of the aircraft. The R.A.F. have done considerable work on this, and it can be said to be successfully developed. In addition to these experiments, eight additional Empire type flying boats strengthened to carry 53,000 lb. instead of the normal 40,500 lb., have been ordered. These will have both greater fuel capacity and carry more useful load for such flights. Machines of the De Havilland "Albatross" class, a four-engined land machine specially designed for this work are also to be used.

R.A.F. High-Speed Flight

THE flight by Squadron Leader J. W. Gillan, on February 10, using a Hawker "Hurricane", a R.A.F. high-speed fighter machine, directs attention to the development that has taken place, both in speeds of modern aircraft and in the methods of navigation. While this was not a properly observed speed record, in the sense that it was timed with great accuracy and afterwards reduced to a speed relative to still air, it was an ordinary flight undertaken under practical conditions upon a standard machine, and should be repeatable, under reasonable weather conditions, as circumstances demand. The flight was made in darkness, leaving Turnhouse Aerodrome, Edinburgh, at 5.5 p.m., arriving at Northolt Aerodrome, London, at 5.53 p.m. The distance was 327 miles, giving an average speed of 408·75 miles an hour, assuming the course to have been the shortest distance between the two points. This speed was helped by a high following wind of at least 50 miles an hour, although not exactly a tail wind on the line of flight. The course was flown entirely blind by the use of instruments. The "Hurricane" is fully equipped in this respect, carrying directional gyroscope, turn indicator, artificial horizon, rate of climb indicator, and a sensitive altimeter. Actually it was a real test of this method of flying, as much of the flight was made through or above cloud entirely obscuring even such landmarks as would have been visible after dark. Also the windscreen was coated with ice at certain stages of the flight, a further hindrance to vision. The machine was climbed slowly to 17,000

feet altitude, and maintained at that height until it was necessary to put it into a slow descent. This occurred over Bedford, one of the few towns that the pilot had been able to see through the clouds. He reported that he had been perfectly comfortable and warm, had had no occasion to use oxygen, and had no feeling of fatigue. The cockpit of this type of machine is entirely covered over with transparent cellulose material, and attention is paid to keeping the pilot warm.

Film illustrating Movement of a Fœtus

AT the meeting of the Royal Society held on February 10, Sir Joseph Barcroft and D. H. Barron showed a film illustrating the development of movement in the fœtus of the sheep. The development of movement was depicted in respect of: (*a*) the types of movement which appear at different fœtal ages, and (*b*) the individuation of certain sorts of purposive movement from a general mass movement. The period of gestation is about 145 days. Up to about 35 days, the fœtus is immobile (type 1). At 35 days it commences to exhibit movements which are always 'jerky' (type 2). At 47–50 days it is almost incessant motion, which is 'sustained' (type 3). After 50 days the fœtus becomes quiescent (type 4). The following analysis may be made of these types: If the spinal cord be cut just below the brain at 60 days, without taking the fœtus out of the uterus, and the fœtus be allowed to continue growing until the cut fibres have degenerated, its body will exhibit jerky movements (type 2), whilst its head is quiescent (type 2). If the central nervous system is transected below the pons, the whole fœtus exhibits jerky movements (type 4). If the central nervous system is sectioned above the red nucleus the fœtus exhibits sustained movements (type 3). The mechanism for the integration of 'jerky' into 'sustained' movements is in the region of the red nucleus, and the mechanism for the inhibition of movement is preponderantly above that. Later parts of the film showed the development of respiratory movements (especially in relation to somatic movement), the development of progressive movement and the development of 'righting' movements.

Development of Calcutta

"THE SECOND CITY OF THE EMPIRE", compiled by Dr. P. C. Bagchi, has been published under the auspices of the Indian Science Congress Association as guide book and souvenir of its silver jubilee meeting recently held in Calcutta. The brochure, which is fully illustrated, gives a historical account of the rise and growth of this city and describes the development of its municipal administration, educational, industrial, public and social services. Calcutta came into existence towards the end of the seventeenth century, and largely owing to its geographical position rapidly grew into an important town. According to the 1935 census, its population now numbers more than a million. The city is mainly industrial and commercial, textiles and tea being two of the chief commodities with which it is concerned. Rapid strides have been made in education during the last century, particularly since the foundation of the University in 1857. To illustrate the more modern developments on the medical side, mention may be made of the opening of the Pasteur Institute in 1924, and more recently still, the Institute of Hygiene and Public Health. The formation of the Vangiya Sahitya Parishad in 1894, for the cultivation and improvement of the Bengali language and literature, has done much to further the study of arts, while the Bose Research Institute, opened in 1917, is an example of the interest taken in pure scientific research.

The Volta Temple at Como

IN *Engineering* of January 7 and 21 and February 4, Mr. F. Walker gives an account of the beautiful Volta Temple at Como, erected as a permanent memorial. The erection of the Temple was made possible by the generosity of Gr. Uff. ou Francesco Somaini, whose commission to the architect Signor Federico Frigerio placed no limits whatsoever on the class of work or expenditure involved. Standing in the public gardens near the edge of a lake in Como, the Temple is a white marble building in the Neo-Classical style, measuring approximately 25 m. in length, 20 m. in depth and 21 m. in height. The main building consists of a large circular hall surmounted by a dome, which is supported by four corner pilasters and eight marble columns. Above the capitals of the pillars is a cornice bearing in gold letters an inscription of dedication. A marble staircase leads to a mezzanuil gallery around the central rotunda, and on the parapet of the gallery are four sculptured panels illustrating incidents in Volta's life. One of these represents him demonstrating his pile to Napoleon at Paris. Though much of Volta's apparatus was destroyed in the fire at the Como Exhibition of 1899, his manuscripts and books were saved and replicas of his apparatus are shown in cases, together with many personal relics. The entire expense for the collection of apparatus has been borne by Signor Somaini, who has further endowed the Temple with a capital of 500,000 lire, the interest of which is to provide scholarships. Mr. Walker's article is accompanied with many photographs of what appears to be the most remarkable monument to any man of science.

Early Hittite Civilization in Cilicia

RESULTS, which at first sight hold out great promise of additions to knowledge of the early stages in the extension of Hittite culture, have been obtained by the Neilson Expedition of the University of Liverpool under Prof. J. Garstang, now engaged in excavating an archæological site near Mersina on the Cilician coast of Asia Minor. A double-walled fortress has been discovered, which is thought to mark the site of a frontier post between the rival southern kingdom of Assawa and the allied State of Kizzuwadna (which seems to have included Tarsus) during the sixteenth or fifteenth century B.C., when the latter stage formed part of the realm of the Hatti, usually identified under the more familiar name of Hittites. According to a report of recent excavations (*The Times*, February 9), deep soundings on a con-

siderable scale have disclosed no fewer than nineteen occupation-levels, belonging to a culture which, though differing, resembles that of the Hittites of the Anatolian plateau closely enough to be considered akin to it. These levels overlie a civilization which would seem to be linked culturally with predynastic Egypt and Sumer. This indicates the incoming of Hittite culture in the fourth millennium B.C., thus antedating considerably the period usually assigned to the foundation of the Hittite capital on the Anatolian plateau. Further soundings in deeper levels have disclosed an even more considerable antiquity, in which this region was evidently a centre of no little cultural activity. Although the succession of painted pottery wares and stylized patterns reflect relationship with the oldest Mesopotamian styles, there is also evidence of local development lasting over a long period. In the lowest level a rich neolithic stratum has been found, similar to that of Sakje Geuzi, in which the most characteristic features are the use of obsidian, for weapons and tools, instead of flint, and a black pottery which is thin and highly finished.

Viking Relic in the British Museum (Bloomsbury)

THE acquisition of a remarkable example of Viking art—it is, in fact, considered to be the most remarkable Viking relic now in existence outside Scandinavia—was reported at the February meeting of the Trustees of the British Museum (Bloomsbury). It is a carving in oak of the head and neck of some beaked creature which formed either the figurehead or the stern-post of a Viking ship. Its precise purpose is at present uncertain. The animal motif, usually highly conventionalized, is one of the most familiar in the decorative art of the north European peoples in the first millennium of the Christian era; but of the zoomorphs, or animal-headed figures, which are known to have adorned the Viking ships, this is believed to be the only surviving example. It is almost four feet nine inches long, and is in the form of a rounded head on a long slender neck. The head curves smoothly into a parrot-like beak, which is open and shows teeth along the edge of the mandibles. The head is well poised on the slender neck, which is covered with a deeply carved lattice pattern, presumably representing feathers or scales. The history of its rediscovery is almost as remarkable as its character. It was found some two years ago during dredging operations in the River Scheldt. Other ship's timbers were brought up at the same time, but unfortunately were not preserved. The importance of the relic was so little appreciated that it was used for some time as a garden ornament. As it is known that the Island of Walcheren at the mouth of the Scheldt was long held by Danish Vikings at the beginning of the ninth century, this zoomorph is attributed to a Danish origin.

Yorkshire 'Bygones'

A COLLECTION illustrating the past cultural history of Yorkshire in the life of both country and town has been presented to the Corporation of York and housed in the old Female Prison, which has been converted into a museum for this purpose. The donor of the collection is Dr. Kirk of Pickering. The collection includes horse brasses, horseshoes, over one hundred insurance plates, and police truncheons, some of which were used in the Chartist and Bread riots. To these have been added fireplaces of various periods, weights and measures of all kinds and periods, and a collection illustrating the history of house lighting; all these exhibits are derived from the past custom of Yorkshire. One of the most instructive is the reconstruction of a Tudor street, some one hundred feet in length, in which are doorways, mounting blocks, shops and other features collected from various parts of the county. Parts of the Female Prison, which was built at the end of the eighteenth century, have been preserved in the original state. The Museum is not yet open to the public, but a private view for subscribers was held on February 5. Among the subscribers are the Carnegie United Kingdom Trust and the Joseph Rowntree Social Trust, Ltd., from each of which the sum of £500 has been received. The historical and geographical position of York makes it a peculiarly appropriate centre for a collection of this kind. The past cultural history of a county embodies much of interest to the student of archæology and ethnology, while custom illustrating its social history survived in a primitive form down to quite recent times, of which it is still possible to find traces in the remoter districts. In these matters, it is true, Yorkshire does not stand quite alone; and although the scheme for a national folk-museum for England seems for the time being to make little progress, it is none the less gratifying to note that local collections are being made before the material has entirely disappeared, as has been shown by recent correspondence in *The Times*.

Hooke's Experiments on Combustion

IN the issue of *Ambix* of December 1937, Dr. D. J. Lysaght publishes an interesting account of Robert Hooke's theory of combustion, which he outlined in "Micrographia" (1665) and amplified in his "Lampas" (1677) and "Cutlerian Lectures" (1679). Hooke's failure to impress his views upon the members of the Royal Society is attributed to his lowly social position, the simplicity of his conceptions, and the innate conservatism of the seventeenth-century mind. Hooke wrote only a scanty account of the experiments upon which he based his ideas, and Dr. Lysaght has done a useful service to historical chemistry by giving a critical discussion of these experiments, as transcribed in Birch's "History of the Royal Society" (1756–57) from the Royal Society's "Journal Book" (1661–87). Hooke's "many luciferous experiments" sufficed to demonstrate all the important facts bearing upon the problem of combustion. "The consumption of a selected portion of the air, the necessity for a continuous supply of this fluid, the formation of heat and light by the 'composition', the existence of solids with the essential constituent of the air 'fixed' in them and available for combustion,

and the increase of weight on calcination must be admitted to be almost all the evidence required for the modern theory. These phenomena were linked up with those relating to respiration. The one fact that was not understood seems to be the part played by the air in calcination . . . and this deficiency prevented the complete synthesis that appears to have been so near at hand." Dr. Lysaght concludes that Hooke's work had the effect of postponing for a considerable time the adoption of the phlogiston theory of combustion.

Unemployment in Colorado

A SURVEY of the Colorado labour market and its "relation to unemployment compensation", by E. R. Livernash of the Massachusetts Institute of Technology, has been issued in the University of Colorado Studies (24, Nos. 3 and 4; 1937). The survey was undertaken in the summer of 1936, and indicates that outside the provisions of the Act there are 45,000 agricultural labourers unemployed and 21,000 domestic servants, as well as a considerable number of those working in trading establishments employing less than eight persons. Unemployment of long duration is regarded as inadequately compensated, this type of unemployment being particularly heavy in the steel, coal and constructional industries and in declining industries such as the southern coal field. The problem of exhausted-benefit unemployment may be of major importance. The recurrent drain of seasonal unemployment, however, may be unwise, as annual earnings are often adjusted on a competitive basis. Much cyclical unemployment appears as seasonal employment, and this may mean a considerable volume of ineligible unemployment in a bad depression. The difficulty seems to be that in future depressions unemployed individuals most in need of relief will find themselves in the exhausted-benefit and ineligible classes. The law may be putting a premium on short-time recurrent unemployment. Mr. E. R. Livernash suggests that experience under the Act, enabling us to classify types of unemployment, may ultimately permit compensation being related more upon the incidence of unemployment, both in occurrence and duration.

A Nature Reserve of Fossil Plants

PROF. G. R. WIELAND made an eloquent plea (*Science*, March 19, 1937), that will be endorsed by the botanists of all countries, for the creation of a national monument on the Black Hills, U.S.A., in which specimens of the remarkable cycadeoid fossils will be exposed *in situ* for study among their natural surroundings. The magnificent photographs of these specimens previously published by Prof. Wieland are evidence how effective such a display would be. His present arguments, indicating the striking parallelisms between these plants and the types discovered in the Carpathians and the Isle of Wight and Isle of Portland and elsewhere, and directing attention to their increased significance in view of the wide vistas on floral morphology in the Gymnosperms opened by the discovery of the marvellous petrified Araucarian forest of the Cerro Cuadrado in central Patagonia, reinforce very powerfully the case for expenditure of time and money in achieving an appropriate display of these unique fossils. The locality is described as very accessible; the horizon is perfectly defined and the quarrying necessary not extensive. It is very much to be hoped that Prof. Wieland's object will be attained and the United States thus obtain a national monument that would be quite unique in its character and clear evidence that that great nation appreciates the value of some of its most remarkable scientific possessions.

London Teachers' Association

AT its annual conference held on February 12, the London Teachers' Association was addressed by its new president, Mr. S. Vanderhook, of Holden Street School, Battersea, on "Current Issues in Education" including, as "the most vital", reduction in the size of classes. The L.C.C. programme for 1938–41 contemplates a reduction of classes in junior schools to 42 and in infants' schools to 44, the standard for senior schools remaining at 40. As it is now twenty-five years since the L.C.C. initiated a scheme for reducing the size of infants' classes to 48 and senior classes to 40 Mr. Vanderhook may well call the new scheme a "small" step forward. A large part of the address has reference to the measures which are to come into operation next year for raising the permissible school-leaving age to 15. The Board of Education's Circular 1457 on this subject is discussed on the lines of the National Union of Teachers' memo. of December 1937. Mr. Vanderhook would, himself, use a short way in dealing with applications for exemption from further school attendance in order to accept "beneficial employment". He would reject them all; for he holds that there is no employment which is beneficial for young persons of fourteen years of age.

Destruction of Sea-Birds by Oil

A LIVELY and informative discussion regarding the destruction of sea-birds by oil waste took place at University College, London, in May last, under the auspices of the University of London Animal Welfare Society, and the report of the meeting has just been published (ULAWS Monographs and Reports, No. 2*a*). Prof. N. K. Adam opened the discussion. A summary of Prof. Adam's special report has already appeared in NATURE of July 17, 1937, p. 100. Many representatives of oil and shipping interests and naturalists took part in the subsequent discussion, the general tenor of which indicated that, in spite of legislation and a 50-mile limit for the discharge of oil, the amount of destruction was still very great, Prof. Adam putting the estimated death-roll of sea-birds at from 10,000 to 200,000 a year. Only international action is likely to be effective in bringing this destruction to an end, and since the maritime nations are almost entirely opposed to the compulsory fitting of oil separators to vessels, efforts are being made to prohibit the discharge of waste oil in certain

areas where the effect is likely to be greatest. Mr. Sanford D. Cole described the Wheeler system by which the cleaning out of oil tanks, double bottoms and bilges is carried out mechanically and much more efficiently than by hand, and suggested that the installation at various ports of separator barges fitted with this American contrivance might go far to diminish the evil of oil pollution.

Sea Shells from Victoria

THE Field Naturalists' Club of Victoria is designing a series of handbooks to foster interest in the State's fauna and flora. The second of the series is by C. J. Gabriel, honorary conchologist, National Museum, Melbourne; it is entitled "Victorian Sea Shells, a Handbook for Collectors and Students", and has been published by the Field Naturalists' Club of Victoria (price 1*s.* 6*d.*). It is well illustrated by Joyce K. Allan, assistant conchologist, Australian Museum, Sydney, with a coloured and several uncoloured plates. Descriptions are given of most of the common sea shells around the coast of Victoria. From a collector's point of view, this little work is extremely useful and will help many to name their specimens. It does not, however, attempt to teach anything about the animals themselves beyond their various habitats. A popular name is given to each shell, in most cases a translation of the specific name. Thus we have the "impoverished Nassarius" and the "sordid sand snail", but there is the banded periwinkle, also known as the "Austral wink", and the black nerite, also known as the "crow". There are a dictionary of terms and diagrams showing the different parts of the shell.

World Congress of Faiths

THE World Congress of Faiths, of which Sir Francis Younghusband is chairman, is arranging a week-end Congress to be held at Cambridge on June 24–28, with residence for men at St. John's College and for women at Newnham College. The subject for deliberation will be "The Renaissance of Religion". Distinguished speakers, representing religions, philosophy and science, will deliver addresses to be followed by discussion. The object for which the World Congress of Faiths is organized is to promote a spirit of fellowship among mankind through religion. The Congress seeks to awaken and develop a world-loyalty, whilst allowing full play for the diversity of men, nations and faiths. Further particulars may be obtained from the secretary, World Congress of Faiths, 36 Victoria Street, London, S.W.1.

Announcements

THE Most Reverend Cardinal Arthur Hinsley, Archbishop of Westminster; Prof. J. Chadwick, professor of physics in the University of Liverpool; and Sir Richard Livingstone, president of Corpus Christi College, Oxford, since 1933 and Vice-Chancellor of the Queen's University, Belfast, in 1924–1933, have been elected members of the Athenæum under the provisions of the rule of the club which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature, the arts, or for their public services.

H.M. THE KING has approved the award of the Royal gold medal of the Royal Institute of British Architects to Mr. Ivar Tengbom (Sweden), hon. corresponding member, in recognition of the merit of his work as an architect. The medal will be presented to Mr. Tengbom at a general meeting of the Institute on April 4.

THE following officers of the Royal Astronomical Society were elected at the anniversary meeting of the Society on February 11: *President*, Dr. H. Spencer Jones, Astronomer Royal; *Vice-Presidents*, Prof. S. Chapman, Prof. H. Dingle, Sir Frank Dyson and Prof. F. J. M. Stratton; *Treasurer*, Mr. J. H. Reynolds; *Secretaries*, Prof. W. M. H. Greaves, Prof. H. H. Plaskett; *Foreign Secretary*, Sir Arthur Eddington.

IN connexion with the movement for the preservation of the fauna and flora of the Empire, attention has been directed to the imperfection of our knowledge of the fauna and flora of Fiji and the Western Pacific High Commission Territories. These Governments have recently expressed the hope that the subject will attract more attention in future. Adequately qualified naturalists desirous of devoting a few months to such studies in these territories under favourable conditions should consult the Under Secretary of State, Colonial Office, Downing Street, S.W.1.

PROF. GÜNTHER ENDERLEIN, the well-known Berlin entomologist and bacteriologist, has recently retired on reaching the age limit.

PROF. HANS BURGER, director of the psychiatric and neurological clinic at the University of Jena, has been nominated a member of the Kaiser Leopold Caroline German Academy of Natural Science in Halle.

THE Gillson scholarship in pathology has been awarded by the Society of Apothecaries of London to Dr. R. H. S. Thompson of the Rockefeller Institute.

THE following appointments and promotions have recently been made in the Colonial Service: Agricultural officers—G. D. Badger, Uganda; T. W. Brown, Malaya; F. E. J. Buller, Nigeria; P. V. Ormiston, Malaya; W. N. Scott, Malaya; A. K. Briant (agricultural superintendent, St. Vincent), Zanzibar; R. P. Davidson (agricultural officer, Uganda), Malaya; H. P. Smart (agricultural officer, British Honduras), senior agricultural officer, Tanganyika. Other appointments—P. Coryndon, inspector of produce, Nigeria; F. E. Harnett, sleeping sickness control officer, Nigeria; J. R. O. Humphries, inspector of plants and produce, Gold Coast; D. W. Le Mare, assistant to the director of fisheries, Straits Settlements.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 334.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Nuclear Photo-effects

THE beautiful experiments of Bothe and Gentner[1] on the ejection of neutrons from heavier nuclei by means of γ-rays with energy of about 17 M.v. resulting from impact of protons on lithium, have revealed a remarkable selectivity of these nuclear photo-effects. Thus a few elements, apparently irregularly distributed, were found to possess cross-sections for such effects of the order 10^{-26} cm.^{2}, while for the large majority of the elements investigated no measurable effects could so far be detected. At first sight this selectivity might, as pointed out from various sides, seem difficult to reconcile with the views on the mechanism of nuclear reactions to which one has been led through the study of the effects initiated by neutron impacts[2]. In fact, the distribution of the energy levels of the compound nucleus formed in such collisions must for all heavier elements be expected to be practically continuous for excitation energies above 10 M.v., while the nuclear photo-effects obviously demand a special sensitivity for much higher excitations confined within well-separated energy regions.

This apparent contradiction disappears, however, if we realize that the level distribution of the compound nuclei, which form the intermediate stage in nuclear transformations initiated by collisions, represents the ensemble of stationary states corresponding to the more or less coupled modes of vibration of the nucleus, while the response to the photo-effects is primarily conditioned by certain special vibratory motions with singular radiation properties. Thus, in nuclear transformations initiated by high-frequency radiation, we have not to do with a simple competition of the disintegration and radiation probabilities of a well-defined intermediate state, but rather with the balance between the radiative processes and the effect of the coupling of the corresponding specific vibrations of the nucleus and the other possible modes of nuclear vibrations. This coupling will tend to the rapid extinguishment of any special features of the initial type of excitation and to its replacement by a more stable state of the excited nucleus, where the energy is distributed among all modes of vibration in a way analogous to the heat motions of a solid body at low temperature. As soon as such a state of nuclear excitation is established, the course of the photo-effect is practically determined. In fact, the radiative properties of the nucleus in this state will resemble that of a black body with a temperature of a few million volts, and the probability that the whole energy is emitted in a single radiation quantum of 17 M.v. will accordingly be negligibly small. Moreover, for the high excitations concerned, the total probability of the radiative processes of the nucleus will be very much smaller than the probability of its disintegration, which increases exponentially with the temperature like in a usual evaporation process.

This argument implies that the cross-section for nuclear photo-effects in the energy region concerned will be given by a formula of the type well known from the theory of optical selective absorption:

$$\sigma = \frac{\lambda^2}{4\pi} \sum_i \frac{\Gamma_R \, \Gamma_C}{(\nu - \nu_i)^2 + \frac{1}{4}(\Gamma_R + \Gamma_C)^2}$$

where λ and ν are the wave-length and frequency of the γ-rays respectively, and ν_i one of the sequence of such frequencies corresponding to maximum resonance. Further, Γ_R and Γ_C are the probabilities in unit time, respectively, for the re-emission of a quantum $h\nu$ from the initial special state of excitation of the nucleus and for the conversion of this transitory state to the ordinary state of nuclear excitation with the same energy. This latter process will be seen to correspond closely to the effect of collisions in diminishing the resonance in absorption of light in gases at high pressures.

Present experimental evidence does not directly disclose for any given element the variation of the cross-section of the selective photo-effect with the frequency of the γ-rays. Still, from the way in which this cross-section varies among the elements for rays with $h\nu$ = 17 M.v., it would appear that the distance between the resonance maxima in this energy region is probably some million volts and that the breadth of each of these maxima is roughly comparable with the variation of $h\nu$ in the incident γ-rays due to natural width of the line and the Doppler effect in the proton-lithium collision which amounts to about 50,000 volts. If, further, the largest cross-sections observed are assumed to correspond to maximum resonance, we get from the above formula values for Γ_R and Γ_C of the order of magnitude 10^{15} sec.$^{-1}$ and 10^{19} sec.$^{-1}$ respectively. Both these values appear quite reasonable. In fact, on account of the high frequency of the γ-rays concerned, we should expect Γ_R to be several times as large as the probability of emission of ordinary γ-rays in nuclear transmutations, estimated from neutron captures to be about 10^{14} sec.$^{-1}$. Further, the value for Γ_C is much smaller than the frequency 10^{21} sec.$^{-1}$ of the initiating γ-rays, while it is much larger than the probability of disintegration of the excited nucleus, estimated by the evaporation analogy to be of the order 10^{13} sec.$^{-1}$ for energies of about 17 M.v.

The proportion between the duration of the initial transitory state and the whole lifetime of the excited nucleus, which for 17 M.v. is thus probably of the order 10^{-6}, should for lower energies be still smaller, since the coupling between the different modes of vibration will presumably decrease much more slowly than the probability of neutron escape. At the same time the ratio between the chances of re-emission of a quantum $h\nu$ from the initial state of excitation and from the more stable state of the excited nucleus will rapidly decrease. Still this ratio,

which for 17 M.v. is extremely large, will scarcely approach unity before we have come well within the energy region of discrete nuclear levels. Even in the upper part of this region, we must therefore be prepared to find a selectivity of the nuclear photo-effect similar to that found in the continuous energy region, but in experiments with sufficient monochromatic γ-rays each resonance maximum will here resolve itself into a fine band of sharp absorption lines corresponding to the separate levels. With the vanishing predominance of the initial state of excitation with regard to the radiation processes, this kind of selectivity, however, will soon disappear and be replaced by a line absorption spectrum of the usual type, which of course will be accompanied by a nuclear photo-effect only so long as $h\nu$ is large enough to cause a disintegration of the nucleus.

In the discussion of these problems, of which a more detailed account will be given in a forthcoming paper in the communications of the Copenhagen Academy of Sciences, I am indebted to my collaborators of the Institute of Theoretical Physics for valuable help, especially to Mr. Fritz Kalckar, whose sudden death a few weeks ago means a most regrettable loss to us all*.

N. BOHR.

Universitetets Institut
for Teoretisk Fysik,
Copenhagen, ø
Jan. 31.

* Cf. p. 319 of this issue.

[1] Bothe, W., and Gentner, W., *Z. Phys.*, **106**, 236 (1937).
[2] Cf. Bohr, N., NATURE, **137**, 344 (1936); and also Bohr, N. and Kalckar, F., *Math. Phys. Comm.*, Copenhagen Acad. Sci., **14**, 10 (1937).

Relativity and Quantum Theory

IT is well known that the transformation theory of quantum mechanics corresponds to the property of the classical equations of motion of being invariant with respect to contact transformations. These are simultaneous transformations of co-ordinates x^k (including time) and momenta p_k (including energy), such that the difference of $p_k dx^k$ in the old and in the new variables is a total differential. The point transformations in the x-space are only a special case; but there exists another case of the same simplicity which can be described as a point transformation in the p-space.

General relativity, on the other hand, is concerned only with point transformations in the x-space; it can easily be seen that the transformation of the p_k induced by the contact condition mentioned above is exactly equivalent to the tensor calculus of relativity. It has struck me that the point transformations in the p-space might be considered in the same way. Thus one is led to a kind of inverted relativity formalism in the p-space in which everywhere space-time and momentum-energy are interchanged. The principle laws of quantum mechanics, such as the commutation laws, the relations of indeterminacy, etc., are symmetrical in x^k and p_k.

These facts suggest very strongly the formulation of a 'principle of reciprocity', according to which each general law in the x-space has an 'inverse image' in the p-space, in the first instance the laws of relativity. The foundation of this idea is too involved to be explained here; it is developed in a paper which has been submitted to the Royal Society. I wish only to press the point that this theory attempts to explain the ultimate particles on relativity considerations without connecting them with the whole universe (x-space)—an idea[1] which seems to me unacceptable for reasons of physical common-sense.

I shall now indicate some simple consequences and numerical results. The principle of reciprocity leads to the introduction of a metric tensor γ_{kl} in the p-space, the coefficients of which are not given numbers but functions in this space which satisfy differential equations in exact analogy to Einstein's gravitational equations for the g_{kl}. The most general form of these contains a 'cosmological term' due to which the x-world is closed and has a finite radius a. The corresponding property of the p-space is this: an energetically closed system corresponds to a closed momentum space, with a radius b, which represents the maximum momentum possible. There are several attempts in the literature[2] to introduce such a maximum momentum, with the purpose of eliminating the disturbing 'infinities' in quantum mechanics; but they had to be rejected since they contradicted relativity. This difficulty is avoided with help of the new principle.

Between the g_{kl} (multiplied by a proper constant A) and the γ_{kl} (divided by A) there will be a relation which is the quantum equivalent of contact transformation, of the form

$$Ag(x) = h^{-3/2} \iiint \frac{1}{A}\gamma(p)\sqrt{-|\gamma|}\, dp_x dp_y dp_z,$$

where $|\gamma|$ is the determinant of the γ_{kl}. In order that g_{kl} and γ_{kl} be dimensionless numbers, one has

$$A^2 = (b/\sqrt{h})^3.$$

The chief consequence of the closed p-space is a change of the expression for the number of quantum cells of a given phase element. This new formula has a great number of applications. The following quantities which are infinite in the accepted theories become finite: The number n of quantum states of radiation in the x-volume V, the zero energy ε of the radiation in V, the self-energy $e^2/r_0 = mc^2$ of the electron; taking the empirical values for c, e, m, one has numerically

$$n = n_0 V, \qquad \varepsilon = \varepsilon_0 n = \varepsilon_0 n_0 V,$$
$$n_0 = 2{\cdot}90 \times 10^{37}\ \text{cm.}^{-3}, \qquad \varepsilon_0 = 59{\cdot}7\ \text{M.e.v.}$$

Between the natural units of length and momentum, r_0 and b, and the quantum constants h and A (defined above), there are the symmetrical relations

$$h = (\pi r_0)b, \quad A^{4/3} = \frac{b}{\pi r_0} = 0{\cdot}0085\ \text{gm./sec.}$$

Coulomb's law is modified by a factor $\int_0^{2r/r_0} J_0(x)dx$, where $J_0(x)$ is the Bessel function. This implies a change of Rutherford's law of scattering, to which is added a factor

$$\left(1 - \frac{E}{E_0}\sin^2\theta/2\right)^{-1},$$

where E is the energy of the incident particle, and E_0 a constant energy which equals 19·200 M.e.v. for the proton-electron collision; for the proton-proton collision where the formula has to be modified (exchange effect) the characteristic energy is 10·4 M.e.v. in good agreement with experimental results[3].

There are further deviations from Planck's and Stephan-Boltzmann's laws; the latter resembles for high temperatures the formula for the heat content

of a crystal, with the characteristic temperature

$$\Theta_0 = 1{\cdot}63 \times 10^{13} \text{ degree.}$$

These deviations are connected with the fact that the pressure of radiation is not equal to $\frac{1}{3}$ of the energy density; Maxwell's equations do not hold in these domains.

The laws of the kinetic theory of gases undergo also an alteration, which for a gas of molecular weight μ begins at a characteristic temperature

$$\Theta = \frac{137}{1845}\frac{\Theta_0}{\mu} = \frac{1{\cdot}21 \times 10^{11}}{\mu} \text{ degree.}$$

The equation of state is unchanged, but the specific heat goes to zero for $T \to \infty$.

The application of the new principle to the structure of nuclei leads to interesting results. A nucleus of mass number A is considered as the densest packing of A particles of mass number 1 (protons, neutrons). Then the radius R of the nucleus is connected with the electronic radius r_0 by

$$R = r_0\sqrt[3]{\tfrac{3}{2}A} = 2{\cdot}02 \times 10^{-13}\sqrt[3]{A} \text{ cm.,}$$

in excellent agreement with Bethe's[4] estimate ($2{\cdot}05 \times 10^{-13}$). The mean kinetic energy $\bar{\epsilon}$ per nuclear particle (proton or neutron) and the maximum energy ϵ_0 are given by

$$\epsilon_0 = \tfrac{5}{3}\,\bar{\epsilon} = 10{\cdot}4 \text{ M.e.v.}$$

The application of the Fermi distribution law together with Bethe's empirical value for the radius leads to $\epsilon_0 = 10$ M.e.v.

These confirmations show that we have to do with more than a mere formalism. Though we are at present far from having a consistent theory, the new principle provides an attractive programme of investigation.

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[2] Born, M., and Rumer, G., *Z. Phys.*, **69**, 141 (1931). Wataghin, G., *Z. Phys.*, **88**, 92 (1934). March, A., *Z. Phys.*, **104**, 93, 161 (1937); **105**, 620 (1937); **106**, 49, 291, 532 (1937); **108**, 128 (1937).

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[4] Bethe, H. A., "Nuclear Physics". *Rev. Mod. Phys.* Part A (with R. F. Bacher), **8**, 82; Part B, **9**, 71; Part C (with M. S. Livingston), **9**, 245. See especially Part B, formula (598), p. 166.

Wilson Chamber Photograph of the Neutro-Electric Effect

AMONG the possible interpretations of the neutro-electric effect, recently discovered by Kikuchi, Aoki and Husimi[1], the disintegration of the neutron into an electron and a proton must be discarded, since Gilbert, Smith and Fremlin[2] could find no corresponding track in the Wilson chamber. (Their estimation that about thirty proton-electron pairs should appear per expansion is no doubt too large; but our present result is also in contradiction to the view of disintegration.) The most reasonable explanation would be to assume the expulsion of the orbital electron or the electron in a negative state due to some still unknown interaction between the electron and heavy particles. In this process, as the neutron loses its energy, the atom with which collision has occurred should gain the corresponding momentum. Therefore, the electron track starting in the Wilson chamber should always be accompanied by a track of a heavy particle.

We searched for such kind of tracks in a Wilson chamber placed near the D–D neutron source filled with methane mixed with alcohol vapour. According to our previous result, the cross-section of the proton for the process is $0{\cdot}6 \times 10^{-26}$ cm.^{2}. Assuming the cross-section for the elastic scattering to be $2{\cdot}0 \times 10^{-24}$ cm.^{2}, 1 in 300 recoil proton tracks should appear in pair with an electron track. From the atomic concentration of the carbon atoms in the chamber and the known cross-section, the ratio of the number of carbon-electron pairs to that of single proton tracks in the same photographs should be about 1 in 200.

WILSON CHAMBER PHOTOGRAPH OF THE NEUTRO-ELECTRIC EFFECT. THE NEUTRON TRAVELS UPWARDS.

We examined about 900 pairs of photographs and obtained 3,060 proton tracks starting from the illuminated portion of the chamber. Of these, six appeared with the electron track. The accompanying illustration shows one of the photographs obtained. The number of the tracks which should be attributed to the carbon-electron pair was 12. These figures are in good agreement with our expectation. For various reasons it is impossible to consider that all the pairs we have observed are due to accidental coincidence of two independent tracks.

There now seems to be no doubt about the reality of the new effect. Its importance in connexion with the theory of the elementary particles can scarcely be over-estimated.

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Dec. 20.

[1] *Proc. Phys.-Math. Soc. Japan*, **18**, 727 (1936); **19**, 734 (1937).
[2] NATURE, **139**, 796 (1937).

A Non-radiating Motion of a Spinning Electron

MATHISSON[1] recently deduced the equations of motion of a spinning electron from the General Theory of Relativity. According to those equations such a particle, when free, instead of following a geodesic, performs some sort of screw motion around it. In the special case when the 'gravitational background' is the space time of the Special Theory of Relativity and the velocity is small compared to the velocity of light, this movement consists of a uniform translation in any direction and a uniform circular motion in a plane perpendicular to the angular momentum **J** of the particle, the frequency ν being proportional to **J**. The radius remains indeterminate. Assuming $\mathbf{J} = h/4\pi$ we get $\nu = 2m_0c^2/h$.

If this particle had the mass m_0 and the charge $-e$ of an electron, the radiation damping of its circular motion would be so great as to stop it almost immediately. Mathisson's attempts to establish a connexion between the Theory of Relativity and quantum mechanics would then obviously encounter unsurmountable difficulties. In the course of a private discussion, Dr. Mathisson expressed, therefore, the view that not only the mass, charge and spin of the particle but also its magnetic moment should be taken into account. It is to be expected, then, that the electronic constants might be chosen in such a way that a free electron would not emit any radiation when moving in the above-mentioned manner. Mathisson is now completing his theory on these lines.

It is possible to show in a very simple 'classical' way that in some particular cases the superimposed action of a magnetic dipole can annihilate the radiation of an electric charge in motion. It is well known that when a magnetic dipole with a moment $\mathbf{q}$ moves with a velocity $\mathbf{v}$, an electric moment

$$\mathbf{p} = \frac{1}{c}\left[\mathbf{vq}\right] \qquad (1)$$

appears. Suppose such a magnetic dipole carrying also an electric charge $-e$ moves uniformly around a circular orbit of radius r, the frequency being ν and the dipole axis remaining perpendicular to the plane of the circle, the electric moment (1) will then be directed along the radius vector of the particle. If we put

$$p = er \qquad (2)$$

and assume that the sense of motion is such as to produce a magnetic moment opposite to $\mathbf{q}$, the action of the resulting electric moment will be equivalent, at sufficiently distant points, to that of a charge $-e$ in the centre of the circle and a charge $+e$ on the particle. The moving electron charge will be compensated and there will remain only a charge $-e$ at rest in the centre of the circle. At distances large enough there will remain thus only an electrostatic field and the radiation will disappear. Putting $q = \frac{h}{4\pi}\frac{e}{m_0 c}$ and $v = 2\pi\nu r$, we get from (1) and (2)

$$\nu = 2m_0c^2/h.$$

Curiously enough, this is also the frequency of Schrödinger's *Zitterbewegung* for a Dirac electron in slow motion.

The above considerations seem to me suggestive, though—or rather because—they are based on such crude 'classical' notions.

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Cracow. Jan. 15.

[1] *Acta physica Polonica*, **6**, 163 (1937) and **6**, 218 (1937).

Coupling between the Orbital and the Spin Angular Momenta of Paramagnetic Ions from Magnetic Measurements

IN a salt of the iron group, though the spin angular momentum of the paramagnetic ion is not directly affected by the crystalline electric fields acting on the ion, yet indirectly it is, owing to its coupling with the orbital angular momentum of the ion, which is easily affected by these fields. The magnetic anisotropy of the crystal, and the deviations of the temperature dependence of its principal susceptibilities from the Curie law, are the results of such an indirect influence of the crystal fields on the spin angular momentum exerted through the spin-orbit coupling[1], and should be the greater the stronger the coupling. Conversely, from the observed anisotropy or the deviations from the Curie law, it should be possible to calculate the strength of the spin-orbit coupling in the ion.

Such a calculation is simple for a nickel salt, and the necessary theoretical expressions have been worked out by Penney and Schlapp[2]. The magnetic anisotropy $\Delta\chi$ for any given plane in the crystal, that is, the difference between the maximum and the minimum susceptibilities in the plane, per gram molecule, is given by the relation

$$\Delta\chi = \frac{8N\beta^2}{3kT}\left(8\lambda - \frac{2\lambda^2}{kT} - 3kT\right) . \Delta\alpha,$$

where λ is the constant of spin-orbit coupling, β is the Bohr magneton, and N, k and T have their usual significance. The factor $\Delta\alpha$ depends on the crystal fields acting on the Ni^{++} ions, and on the orientation of the selected plane in the crystal. Because of the small coefficient of thermal expansion of the crystal, $\Delta\alpha$ will be almost independent of temperature. From measurements on $\Delta\chi$ at two different temperatures it should therefore be possible to eliminate $\Delta\alpha$ and determine λ.

Using the method described by us in some recent papers[3], we have measured the magnetic anisotropies of the tetragonal crystals $NiSO_4.6H_2O$ and $NiSeO_4.6H_2O$, at the temperature of liquid oxygen and at room temperature. For both the crystals the anisotropy at $-183°$ C. is found to be about $4{\cdot}8_6$ times that at 23° C. From this ratio we obtain for the constant of spin-orbit coupling in Ni^{++} the value $\lambda = -331$ cm.$^{-1}$, which agrees well with the value -335 cm.$^{-1}$ obtained from spectroscopic data[4].

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[1] Van Vleck, J. H., *Phys. Rev.*, **41**, 208 (1932).
[2] *Phys. Rev.*, **42**, 666 (1932).
[3] Krishnan, K. S., and Banerjee, S., *Phil. Trans. Roy. Soc.*, A (1933–36).
[4] Laporte, O., *Z. Phys.*, **47**, 761 (1928).

Diffraction Gratings ruled in Metallic Films

PROF. R. W. WOOD, of Johns Hopkins University, has recently reported[1] on the successful preparation of diffraction gratings by ruling on 'aluminized' surfaces, and predicts a bright future for this type of dispersive instrument. One of the most interesting aspects of this technique, however, is not included in his letter. Inasmuch as I participated in the conception and development of the general method of preparing and ruling evaporated films at Cornell University early in 1934, which method Prof. Wood was induced to adopt about a year later, I feel that I am in a position to offer some comments of interest.

Diffraction gratings are not ruled upon 'aluminized' mirrors but rather upon mirrors the surfaces of which are coated with a discrete film of aluminium deposited over a film of chromium. It was found in the early attempts to rule gratings in evaporated films of pure aluminium that the aluminium film was stripped in patches from the glass by the diamond point, while films of pure chromium were so hard that a diamond loaded heavily enough to rule the chromium also

disfigured the surface of the glass underneath. Hence it was rightly concluded that a double film might serve, since the diamond could be caused to rule through the soft aluminium without being loaded heavily enough to affect the under-coating of chromium. At the same time the aluminium-chromium bond would not be disturbed, for the tenacity of an aluminium film for one of chromium is far greater than that of an aluminium film for glass. It is of interest to note here that this search for a proper film for ruling diffraction gratings has led to the development of a type of film, called 'chroluminum', now extensively used for coating large astronomical mirrors.

The double film has ideal properties for the ruling of diffraction gratings in that the glass surface is not touched by the diamond point, and in that the depth of the rulings can be controlled accurately by controlling the thickness of the aluminium film. The first property allows the same figured and polished mirror blank to be used over again in case the first ruling is a failure, since the chroluminum surface can be removed easily from the glass and a new one deposited for another try at ruling. The second property allows rulings of any desired depth to be obtained with comparative ease, and thus allows most of the light of the reflected spectra to be concentrated in a desired colour of a desired order. The thickness of the aluminium film through which the diamond point is to rule is computed in advance, and is controlled during the process of deposition of the aluminium. The thickness of the underlying chromium film is of little importance, and is usually made slightly less than that necessary to give opacity.

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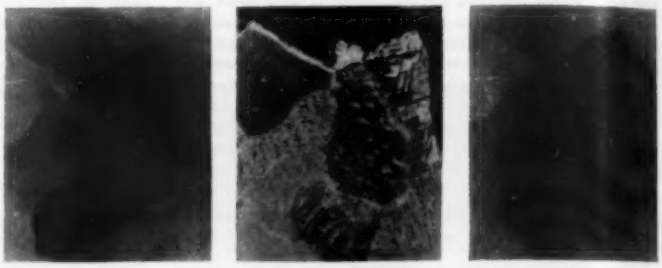
[1] NATURE, 140, 723 (1937).

Electron-Optical Observation of the Transition of α- into β-Zirconium

THE investigation of the transformation process of the hexagonal α- into the cubic β-modification of zirconium by means of X-rays[1] led to the conclusion that this process is brought about by a homogeneous transformation (shearing combined with dilation) of coherent lattice regions parallel to definite crystallographic planes and directions, the 'shearing motion' being opposed in successive $\alpha \rightarrow \beta$ and $\beta \rightarrow \alpha$ transitions, the whole process thus resembling closely the way martensite needles are formed in steel.

In such cases it is generally observed that the transformation into the new phase cannot be described as a growth of nuclei steadily increasing in size, but that it consists of the formation of parallel and intersecting systems of more or less needle-shaped lamellæ, which, as transformation progresses, do not increase in size but merely in number, the resulting pattern showing the type of lamellar structure met with in martensitic steels and known as *Widmannstätten* texture in meteorites and many alloys[2].

The investigation of the emission pattern of zirconium in an 'electron microscope' of the type described elsewhere[3], showed that the same texture is exhibited by α-crystallites formed from the β-phase. This is clearly shown by the accompanying photographs corresponding to cathode temperatures of 1100° C., that is, well above the transition point, (865° C.) and 600° C., a temperature well below this point. It is interesting to see that the regions, originally occupied by the β-crystallites, can still be discriminated in the α-pattern by the difference in



β-Zr (1100° C.) α-Zr (600° C.) β-Zr (1150° C.)

EMISSION PATTERNS OF ZIRCONIUM ABOVE AND BELOW THE TRANSITION POINT (865° C.).*

'direction' of the lamellæ in the adjoining regions (needles of the α-modification of zirconium have already been observed in etched test pieces after suitable cooling from the β-state[4]).

On retransformation into the β-state, the original crystallites reappeared, as is evident from the photograph at 1150° C., which (apart from the left-hand side, where crystal growth has already started: see below) is practically identical with that at 1100° C. This behaviour, which is totally different from the phenomenon of crystal growth observed on transition of α into γ iron[5], seems to confirm the conclusion deduced from the X-ray investigation mentioned above.

It seems worth mentioning that at a cathode temperature above 1150° C. the β-crystallites showed phenomena of growth, whereby the capacity for growth of the individual crystallites could be influenced by the insertion of a temporary transition into the α-modification.

A detailed account of these observations will be published in *Physica*.

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* The striation visible in the β-Zr patterns has the same direction over the whole cathode and is due to the polishing of its surface.

[1] Burgers, W. G., and Jacobs, F. M., *Physica*, **1**, 561 (1934); Pap. Disc. Intern. Conf. Physics, London, 1934, vol. 2, p. 158.

[2] See Sachs, G., "Praktische Metallkunde", **3**, 20 (Berlin, 1935); further papers by Mehl, R. F., and collaborators in *Trans. A.I.M.E.* from 1931 onwards.

[3] Burgers, W. G., and Ploos van Amstel, J. J. A., *Physica*, **4**, 5 (1937).

[4] See Vogel, R., and Tonn, W., *Z. anorg. allg. Chem.*, **202**, 292 (1931), Burgers, W. G., and Jacobs, F. M., *Physica*, **1**, 561 (1934).

[5] Burgers, W. G., and Ploos van Amstel, J. J. A., NATURE, **136**, 721 (1935); *Physica*, **4**, 15 (1937).

A Modified Phase Rule Equation

It is well known that the Gibbs Phase Rule as applied to equilibrated macro-systems subject to changes of temperature, pressure and concentration may be written in the form

$$P + F = C + 2,$$

where P is the number of phases, F the number of degrees of freedom and C the number of components. In applying the equation to physical and chemical equilibrium, the number of components C is taken as the *minimum* number of independently variable constituents in terms of which the equilibrium may be expressed in the form of a chemical equation. The term 'number of components' has thus to bear the brunt of the matter and assume a responsibility not shouldered by the equation itself. In fact, it is frequently necessary to write out a properly balanced chemical equation in order to decide upon the number of components in the system. Moreover, the equation cannot be applied without making allowance for certain restrictions when the phases approach identity, as in critical phenomena, or when one of the substances is kept in a definite weight-ratio to some other substance in the system, as in dissociation phenomena.

In view of these difficulties it is perhaps desirable to state the Phase Rule in terms more readily comprehended by the ordinary chemist and metallurgist. If we retain the original definitions of phases and degrees of freedom and let C be the *total* number of chemical constituents (that is, actual chemical substances) present in the system we may write

$$P + F + R = C + 2 - r,$$

where R is the number of reversible chemical reactions occurring in the system, and r, the restriction term, is equal to the number of pairs of phases having the same concentration or composition. This equation may then be applied without reference to stoichiometric chemical equations and without recourse to any process of choosing components.

Thus in the thermal dissociation of calcium carbonate:

$$CaCO_3 \rightleftarrows CaO + CO_2,$$

we have three constituents and one reversible chemical reaction so that

$$3 + F + 1 = 3 + 2 - 0; \text{ that is, } F = 1.$$

Again, in the dissociation of ammonium chloride

$$NH_4Cl \rightleftarrows NH_3 + HCl,$$

we have a reversible chemical reaction and also one pair of phases (the solid phase and the gas phase) with identical composition, so that

$$2 + F + 1 = 3 + 2 - 1; \text{ that is, } F = 1.$$

The equation also leads to a clear differentiation between physical and chemical change in transition processes. We know, for example, that the system

$$Na_2SO_4 \cdot 10\,H_2O \rightleftarrows Na_2SO_4 + \text{liquid}$$

containing three substances (decahydrate, anhydrous salt and water) is invariant (that is, $F = 0$). Accordingly,

$$4 + 0 + R = 3 + 2 - 0 \text{ and } R = 1.$$

The point is thus an incongruent melting point arising from the rupture or formation of chemical linkages.

A similar behaviour is exhibited by an intermetallic compound with a submerged maximum, as, for example,

$$AuSn_4 \rightleftarrows AuSn_2 + \text{liquid};$$

but in this case the linkages involved are metallic. These transition processes are conveniently termed *meritectic* reactions (from *meros*, part; *tectic*, melting) to distinguish them from the ordinary peritectic reactions of solid solutions. Applying the equation to a binary system of two solid solutions undergoing peritectic reaction,

$$\alpha \rightleftarrows \beta + \text{liquid},$$

we have

$$4 + 0 + R = 2 + 2 - 0; \text{ and } R = 0.$$

It is clear, therefore, that the peritectic transformation of solid solutions does not involve the rupture of chemical or metallic linkages.

The modified equation, while removing the bugbear of the term component, is also of utility in other directions and in my opinion is much more easy to apply than the customary equation.

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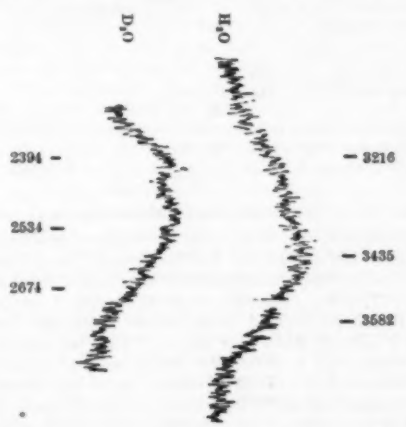
Constitution of Heavy Water

On lines similar to the investigation by one of us on ordinary water[1,2], we have studied the Raman band of heavy water (99·6 per cent D_2O) at different temperatures ranging from 6° to 100° C. Within this range, the principal band for this substance is very broad and diffuse, extending in its Raman frequencies from 2,254 to 2,784 cm^{-1}. It shows a structure similar to that of ordinary water, having at 30° C. three components merging into one another



with their maxima at 2,394, 2,534 and 2,674 cm^{-1}. The one important characteristic of this band, as compared to that of ordinary water, which earlier workers with this substance[3,4,5] failed to record, is the difference in the relative intensities of the three components. The accompanying microphotometric curves of the bands for the two types of water were taken at 30° C. It is clear from the curves that for

heavy water, the marked components are better resolved, the first component with Raman frequency 2,394 being nearly of the same intensity as the second, whereas for ordinary water, the first component is not only not well resolved from the second, but is also less intense.

With the view of ascertaining the cause of this difference, the changes with temperature in the relative intensities of the three components for heavy water were investigated. The results revealed, in general, a similarity in the changes for the two kinds of water, but the structure of the band for heavy water at any temperature is analogous to that for ordinary water at a lower temperature. Owing to the extreme diffuseness of the bands, it is difficult to determine the exact values of the corresponding temperatures.

If these components are attributed to different polymers, namely, single, double and triple molecules[1], the difference in the relative intensities of the components for the two types of water at the same temperature indicates a difference in the relative proportions of their polymers. The similarity in the structure of the band for heavy water at any temperature to that of ordinary water at a lower temperature leads to the conclusion that characteristic temperatures for heavy water should be higher than for its isotopic analogue. This observation is confirmed from experiment, the temperatures of freezing, maximum density and boiling being 3·8°, 11·6° and 101·4° C. respectively.

For heavy water, the component with the smallest frequency at 2,394 cm^{-1}, which we attribute to $(D_2O)_3$, diminishes in intensity with increasing temperature, whereas the third component (2,674 cm^{-1}) increases correspondingly, the central component attributed to $(D_2O)_2$ remaining almost unaltered. These results indicate that the equilibrium between the polymers changes with temperature as for ordinary water.

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Dec. 23.

[1] NATURE, **132**, 480 (1933).
[2] *Proc. Roy. Soc.*, A, **145**, 489 (1934).
[3] Wood, R. W., *Phys. Rev.*, **45**, 392 (1934).
[4] Ananthakrishnan, R., *Proc. Ind. Acad. Sci.*, **2**, 291 (1935).
[5] Bauer and Magat, *C.R.*, **201**, 667 (1934).

Ethnographical Museums

RECENTLY, there has been a certain correspondence in the Press about the India Museum, and now the question has been ventilated in NATURE of January 29 (pp. 177, 193). Though, unfortunately, I have only the usual superficial knowledge of things Indian, may I discuss the wider point of view of archæology and ethnology in general? These are, of course, one and the same, the latter being only the former in the present tense. This point is indeed made in the remark regretting "the present divorce of antiquity from historic times".

A museum is, or should be, a centre of teaching and study, where everyone should have facilities for acquiring knowledge and broadening his interests in mankind according to his ability. This, of course, means teaching for the serious student, and general information for the vaguely interested public.

Coming back to the particular case in point, we may notice that the purpose of the Victoria and Albert Museum, of which the India Museum is a section, is "to promote the application of art to manufactures". Yet I have noticed that it is Indian 'art' that is so much mentioned in the recent correspondence. Is all the emphasis once again to be laid on 'art' to the detriment of 'industry'?

Alas, after literature, art has formed the greatest obstacle with which the new study of man's accomplishment has had to contend. All the world over, whether in ancient Egypt, in China, in the Muslim world, or in Europe, the approach to the past has always been primarily through an appreciation of the written word. Later has come an appreciation of the beautiful works of the past. It is only within the last fifty years or more that the new study of archæology and ethnology has grown up. That is a study of all the phenomena of any given civilization—not only of the things beautiful, but also of those that never aspired to beauty or sank into ugliness, but were merely made for everyday use.

The studies of literature and of art have been firmly entrenched in man's mind for many hundreds of years, and have produced their own splendid results. Hence, many find difficulty in discerning the new science. Then, if it begins to dawn upon them, they are liable to look upon it merely as an aberration of those who are not good enough to scale the heights of the others. It should, however, stand forth clearly as the independent line of study which it is, with its own methods and leading to its own results, just as do the other two.

Neither art nor literature is the whole of man's activities, but each is a part of them, just as much as the industries of flint-working, potting, weaving, carpentry, mechanics or any other.

Hence a museum should not be, as it used to be, a collection of things quaint or curious, or even of a few superlatively beautiful ones. It should, on the contrary, give a comprehensive view of a people's complete activities, good, bad and indifferent. These activities cannot be studied properly without reference to those of surrounding countries. Fortunately, an understanding of this has been growing recently. It is now many years since Sir Flinders Petrie began clamouring for a central institution which would cater for this sort of thing, and only last year a prize was offered for an essay treating of Egyptian archæology on these lines.

Finally, it may be remarked that an attractive display of objects will always appeal to people, whereas a learned treatise will only repel the majority.

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Solubility of Cellulose in Water

PURE cellulose is generally regarded as being perfectly insoluble in water, but experiments recently carried out in this laboratory indicate that pure cellulose is slightly soluble in pure water.

High-grade bleached commercial grades of cellulose contain water-soluble impurities (both organic and inorganic), usually less than 1 per cent. This water-soluble extract is determined by digesting a weighed sample of the cellulose for 2 hours on a water-bath

with twenty times its own weight of water and filtering off the extract. This operation is repeated another three times and the combined four filtrates are evaporated to dryness on the water-bath, the residue being weighed and calculated as the water-soluble content of the cellulose.

My own experiments show, however, that when this method of extraction is continued on the same sample, after the above determination of water soluble content, approximately constant weights of residue may be recovered from subsequent extracts in a long series of extractions.

Hydrolysis was suspected at this temperature of extraction (95–100° C.), and a further series of experiments were conducted with very pure distilled water at ordinary temperatures (15–18° C.) in carefully selected apparatus, when it was found that the extracts again gave a lower but still approximately constant residue after repeated extractions.

In one case a sample of cellulose, weighing 10 gm., after removal of water-soluble impurities, was digested and washed in the cold with 20 litres of distilled water, corresponding to fifty extractions, without diminution of the residue obtained from the last extract. Micro-biological attack of the cellulose was considered as a possible explanation, but after consideration of microscopical and other evidence, was discarded. The following are typical of the results obtained when using 20 gm. samples stirred in 800 c.c. water for 2 hours at 15–18° C.:

Cellulose	Average Water-soluble Residue in Extracts
A. Bleached spruce wood (sulphite process)	18·6 mgm. per litre
B. " "	21·0 " " "
C. Alpha-Cellulose from B	13·6 " " "
D. Bleached cotton wool	20·6 " " "

The residue obtained from the extracts after evaporation, when final drying is done in a desiccator over phosphoric acid, appears as a white film, having a uniform granular appearance. Under the microscope, it is largely colloidal and isotropic but contains some scattered crystallites. The residue, if not charred during drying, is soluble in water and the solution shows a reducing action equivalent to about 15 per cent calculated as glucose. Whether this hydrolysis has taken place during extraction or evaporation of the extracts remains to be determined. Evaporation of a concentrated solution of the residue yielded a transparent brittle gum-like substance giving negative reactions for the presence of crystalline cellulose or of dextrin.

One fact appears certain, namely, that pure cellulose is slightly soluble in pure water at ordinary temperatures to the extent of 1·4 to 2·1 parts per 100,000, forming a perfectly clear sol. This dispersion of cellulose in water is probably accompanied by some breakdown in the cellulose molecule, but the nature of the reaction will take some time to determine.

This slight solubility of cellulose in water obviously sheds light on numerous scientific and technical problems involving the physical and chemical reactions of cellulose, from its origin in the cell-wall to its resolution by bacteria.

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'Convergent' Sunbeams

THE phenomenon of 'divergent' beams of sunlight is known to everyone. The illusion of divergence of the beams is so good that one has forcibly to remind himself that they are really parallel.

One day last summer, I observed 'convergent' beams and this observation was corroborated by others with me. It was late afternoon in a flat country. Clouds hid the sun, which, perhaps, was nearly eclipsed by the horizon. It had been raining in the surrounding country and cumulus clouds were still prominent in the west. The rays of the setting sun gave the familiar fan-like pattern in the west, passed almost invisibly overhead and then 'converged' in the east as if they emanated from a sun on the eastern horizon. These rays were of lower intensity than those in the west but were plainly visible.

The explanation of the phenomenon is obvious; one is under the parallel beams, and looking along them in opposite directions. The spectacle was new to me.

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Toledo, O.

Origin of Stellar Energy

IT is well known that matter consists of nuclei and electrons. Nevertheless it can be shown that in bodies of very large mass, this usual 'electronic' state of matter can become unstable. The reason for this lies in the fact that the 'electronic' state of matter does not lead to extremely great densities, because at such densities electrons form a Fermi gas having an immense pressure. On the other hand, it is easy to see that matter can go into another state which is much more compressible—the state where all the nuclei and electrons have combined to form neutrons.[1] Even if we assume that neutrons repel each other, this repulsion can become appreciable only at densities of the order of magnitude of nuclear densities, that is, 10^{14} gm./cm.^{3}, and the pressure of a Fermi gas consisting of neutrons is much less than that of an electronic gas of the same density, because of the greater mass of the neutrons.

Therefore, in spite of the fact that the 'neutronic' state of matter is, in usual conditions, energetically less favourable, since the reaction of neutron formation is strongly endothermic, this state must nevertheless become stable when the mass of the body is large enough. In this case, the gravitational energy gained in going over to the neutronic state with its greater density, compensates for the losses of internal energy.

It is easy to compute the critical mass of the body for which the 'neutronic' state begins to be more stable than the 'electronic' state. First of all we must calculate the energy necessary to form one neutron. For example, in the reaction $^{16}_{8}O + 8e^- = 16^{1}_{0}n$, we find from the mass defects that to form one neutron the energy required is 0·008 mass units or $1{\cdot}2 \cdot 10^{-5}$ ergs (7·5 Mv.). To transform one gram of matter into neutrons we thus need 7×10^{18} erg./gm.

Now we must calculate the gain in gravitational energy. The gravitational energy of the much less dense 'electronic' state can, of course, be neglected. Let us assume first of all that the neutronic state has a constant density, 10^{14} gm./cm.^{3}. The gravitational energy of a homogeneous sphere

of mass M is then $3 \times 10^{-3} M^{5/3}$ ergs. For the stability of the neutronic phase we must then have $3 \times 10^{-3} M^{5/3} > 7 \times 10^{15} M$, or, $M > 10^{23}$ gm. $= 0{\cdot}05$ ⊙, where ⊙ is the mass of the sun. On the other hand, if we assume that the neutrons behave like a Fermi gas, we find for the energy $7 \times 10^{-23} M^{7/3}$ ergs and hence

$$M > 1{\cdot}5 \times 10^{30} = 10^{-3} \odot$$

which critical value is even less than on the first assumption.

When the mass of the body is greater than the critical mass, then in the formation of the 'neutronic' phase an enormous amount of energy is liberated, and we see that the conception of a 'neutronic' state of matter gives an immediate answer to the question of the sources of stellar energy. The sun during its probable time of radiation (about 2×10^9 years according to general relativity theory) must have emitted something of the order of magnitude of 3×10^{52} ergs. The liberation of this amount of energy requires the transition of only about 2 per cent of the mass of the sun (with the assumption of constant density) or even only 3×10^{-3} ⊙ (with the Fermi gas model) to the 'neutronic' phase. Even for such a bright star as β Orionis, we find for the mass of the neutronic core only about $0{\cdot}1$ ⊙ (with the Fermi gas model).

Thus we can regard a star as a body which has a neutronic core the steady growth of which liberates the energy which maintains the star at its high temperature; the condition at the boundary between the two phases is as usual the equality of chemical potentials. The detailed investigation of such a model should make possible the construction of a consistent theory of stars.

As regards the question of how the initial core is formed, I have already shown[2] that the formation of a core must certainly take place in a body with a mass greater than $1{\cdot}5$ ⊙. In stars with smaller mass the conditions which make the formation of the initial core possible have yet to be made clear.

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[1] Cf. Hund, F., *Erg. d. exakten Naturw.* **15**, 189 (1936).
[2] Landau, L., *Sov. Phys.*, **1**, 285 (1932).

Points from Foregoing Letters

CONTRARY to expectations, γ-rays of 17 million volts energy eject neutrons from the nuclei of some of the heavier elements only. Prof. Niels Bohr suggests that this selective behaviour is conditioned by "certain special vibratory motions with singular radiation properties" and these, together with other possible modes of vibration, lead to an energy distribution analogous to that of the heat motions in a solid body at a low temperature. The radiative properties of the nucleus in this state will resemble that of a black body with a temperature of several million volts. Based on this analogy Prof. Bohr gives a formula of selective absorption, relating the cross-section for nuclear photo-effects with the frequency of the incident γ-rays and the probabilities for the re-emission of a quantum.

Prof. Max Born proposes a 'principle of reciprocity' according to which each general law in x-space (space-time dimensions) has an 'inverse image' in the p-space (of momenta and energy). He indicates some of the consequences and numerical results: An energetically closed system would correspond to a closed momentum-space, with a radius c representing the maximum possible momentum. A number of quantities which are infinite in accepted theories become finite. Coulomb's law is modified, which implies a change in Rutherford's law of scattering so that for head-on collisions there is an absolute limit for the distance of closest approach. Plank's and Stephan-Boltzmann's laws and the laws of the kinetic theory of gases are altered. Applied to the theory of nuclear structure, the new principle yields, for the mean kinetic energy per nuclear particle and for the ratio between the nuclear and electronic radii, values in excellent agreement with Bethe's estimates.

Wilson chamber photographs showing the emission of the electron from atoms when they interact with neutrons are submitted by S. Kikuchi and H. Aoki. The authors assume the expulsion of an orbital electron or an electron in a negative state, due to some unknown interaction between the electron and heavy particle.

According to Dr. J. W. Weyssenhoff, from the simple classical theory it follows that, in particular cases, the superimposed action of a magnetic dipole can annihilate the radiation of an electric charge in motion. This may remove the difficulty in connexion with Mathisson's theory of the spinning electron since the moving electron charge will be compensated so that there is no radiation.

In a paramagnetic salt it should be possible, according to Prof. K. S. Krishnan and A. Bose, from measurements on the magnetic anisotropy of the crystal at different temperatures, to calculate the coupling between the orbital and the spin angular momenta of the paramagnetic ion. The value of the coupling in Ni^{++} calculated in this manner agrees well with the spectroscopic value.

Photographs of electron-emission patterns of α-zirconium (at 600° C., cathode temperature) and of β-zirconium (at 1100° C.) submitted by Dr. W. G. Burgers and J. J. A. Ploos van Amstel show that, as in the case of martensite, a *Widmannstätten* texture is exhibited by α-crystallites formed from the β-phase. On retransformation into the β-state, the original crystallites reappear, showing phenomena of growth.

The difficulties associated with the application of the Gibbs Phase Rule equation arise from the special significance which is attached to the term component. A modified equation proposed by Dr. S. T. Bowden avoids the use of this term and leads to a clear differentiation between the phase transformations of compounds and solid solutions.

Pure cellulose is generally regarded as being perfectly insoluble in water, but from investigations described by James Strachan, it appears that high-grade cellulose from wood and from cotton is slightly soluble in pure water at 15–18° C. to the extent of 1·4 to 2·1 parts per 100,000, and that this dispersion of cellulose in water is probably accompanied by some breakdown in the cellulose molecule.

Research Items

Ancient Man in Devon

THE implementiferous gravels at Broome, Dorset (the gravels in question are actually over the county boundary in Devon), have long been famous. Chert implements were discovered there in 1877–78. Mr. Reid Moir has now investigated these gravels and the contained implements in the light of the knowledge of quaternary deposits and 'palæolithic' implements which has accrued since the gravels and implements were originally described (*Devon Archæol. Exploration Soc.*, **2**; 1937). The gravels were regarded in earlier investigations as laid down by normal river action; but it cannot be questioned that, during the Ice Age, Devon, so near the main terrain of the glaciers, must have been affected by the tremendous happenings of the period. The deposits must therefore be regarded as laid down by an abnormal flow due to the melting ice. It would appear that some twenty feet of the deposit was laid down as a result of the passing away of glacial conditions. Then comes about four feet of comparative quiescence, in which palæolithic hunters may have lived on the river bank. Another period of very active deposition follows in which the uppermost thirty feet of gravels was laid down. This is only vaguely stratified, or 'tumbled'. The archæological evidence fits in with this hypothesis. The specimens from these deposits can be classified as (*a*) primitive, possibly eolithic, implements, much rolled and abraded; (*b*) one or two early Acheulean hand-axes showing signs of transport; (*c*) Late Acheulean hand-axes, fine and unabraded; (*d*) Clacton III material unabraded; (*e*) some Levallois flakes, but not a definite Levallois industry. There can be no doubt that the middle layer was laid down in Late Acheulean and Clacton III (High Lodge) times. The Broome deposits fall in line with the 100-ft. terrace of the Lower Thames Valley, Derby Rd., Ipswich, and Hoxne, Suffolk. The lower deposit of Broome, therefore, is connected with the glaciation of the Kimmeridge Chalky Boulder Clay and the uppermost with the Upper Chalky Boulder Clay; while there is strong evidence for correlating the upper gravels with the deposit of 'clay with flints' of East Devon on the Bere–Seaton Road, a site which Mr. Reid Moir also discusses.

Mesolithic Flints from West Hartlepool

Finds of worked flints from the submerged forest at West Hartlepool, which have the appearance of an early stage of the Maglemose culture, or possibly even more primitive and suggestive of that of Duvense, Lübeck, have been recorded by Dr. C. T. Trechmann, Mr. A. S. Kennard adding a note on the Mollusca (*Proc. Prehist. Soc.*, July–Dec. 1936). The submerged forest is situated between Hartlepool and West Hartlepool and along the coast southward to Seaton Carew. The main portion occupies a depression between two outcrops of magnesian limestone. A mammoth tusk, antlers of red deer and Irish elk, and other mammalian remains have been found beneath the deposit. A rough but well-chipped pick-like flint implement, now in the Sunderland Museum, was found "on the turf of the buried forest" at Seaton Carew in 1860. In 1934–35, flint flakes and chippings and a fresh shell of *Littorina littorea* were found at West Hartlepool near the base of the peat, while a patch six feet long and three feet wide yielded a quantity of very sharp implements and chippings of very black flint with white chalky patches and streaks. These appear to be the work of one person thrown down together. The fifty specimens, all found at the junction of the underlying blue clay with the peat, included a number of elongated micro flakes, a microlith blunted down one edge, a micro-burin and a broken, asymmetrically notched flake, probably a microlith in process of manufacture. In the peat itself are found indefinitely chipped flints of an elongated shape, not easy to comprehend, but in certain characters recalling the pick in the Sunderland Museum. It seems possible that two periods are represented, one at the base and the other higher up in the peat. The peat is very compressed and contains birch, hazel, *Equisetum*, iris, etc. Permeation by drain refuse makes pollen analysis unsatisfactory. The period is early Littorina or Atlantic. The worked flints are of Maglemose type, and a comparison with other sites of the submerged forest regions of the Yorkshire, Durham and Northumberland coasts suggests that the worked flints found at Skipsea are of like appearance.

Inactivation of Adenosine by Blood

ALL tissues of the body contain in greater or less amounts adenosine or allied compounds, substances which, when they enter the blood-stream, have far-reaching physiological effects. The existence of enzyme systems in the tissues capable of inactivating these substances has been known for some time, but up to the present no such enzymes in the blood have been described. Drury, Lutwak-Mann and Solandt (*Quart. J. Exp. Physiol.*, **27**, 215; 1938) have now demonstrated the presence in the blood plasma of the ordinary laboratory animals and of man of an enzyme inactivating adenosine, probably by deaminating it to form the biologically inert substance inosine. Cat's plasma is by far the most active, 0·1 mgm. of adenosine being destroyed in so short a time as 2 min. by 1 c.cm. of plasma. This very high degree of activity is, however, exceptional and is only reached on account of the remarkable fact that the activity of the plasma of anæsthetized animals gradually increases during an experiment, until 5–6 hours after the beginning of an experiment it may be 12 times the normal value. Although this increase appears to be accelerated by a fall of blood pressure, the authors are unable to correlate it directly with this, and it appears to be unconnected with the presence of any particular organ. The authors suggest that the increase in enzyme activity may be due to the formation of more enzyme from inactive plasma protein.

Larvæ and Pupæ of Aquatic Diptera

MEMOIR 205 (1937) of the Cornell University Agricultural Station is written by Prof. O. A. Johannsen and forms Part 3 of a series entitled "Aquatic Diptera". In the present case, the single family Chironomidæ is dealt with and, in particular, four out of five of its sub-families. The Chironominæ are

the family left out to be dealt with in a subsequent memoir. While this work deals primarily with North American genera and species, the keys include European forms in some cases where it is considered desirable to direct attention to differential characters. The work is illustrated by eight plates containing more than 270 line figures. Since practically all the European genera are figured, the work will prove a valuable aid to the identification of forms found on both sides of the Atlantic Ocean. The material which forms the basis of the study was collected and reared by the author and some of it a number of years ago. Parts IV and V, which conclude the series, it is mentioned, have been completed and will appear as another memoir within a short time. When completed, the work will form an admirable and up-to-date guide to the study of the many forms of Diptera found in aquatic habitats.

Crustacea of the Philippines

A CHECK list of Philippine Island decapods is given by P. Estampador Eulogio (*Philippine J. Sci.*, **62**, No. 4; 1937), but there are many additions to the fauna recently described from Woltereck's Wallacea Expedition to the Philippine and adjacent islands. The contributions already published are summarized by Dr. Woltereck in Band 34, Heft 3/5 of the Internationale Revue der gesamten Hydrobiologie und Hydrographie, 1937. This number is devoted to the Wallacea Expedition, and includes original contributions, especially on the freshwater Crustacea, by H. Balss (Potamonid crabs), V. Brehm (Diaptomids), W. L. Tressler (Ostracods) and E. Woltereck (freshwater Caridea). The Potamonid crabs are common in this region, living much on land and having no free-swimming larvæ. Dr. Woltereck has two important and extensive papers, the first dealing with races and species of the genus *Caridina* present in the islands, the second with their systematics and geographical distribution. The latter includes a list of all known species and a comparison with other Atyidæ.

Researches on Copepods

DR. C. H. EDMONDSON has studied copepods in Hawaii, Fiji and Tahiti (Quantitative Studies of Copepods in Hawaii with Brief Surveys in Fiji and Tahiti; Occasional Papers of Bernice P. Bishop Museum, Honolulu, Hawaii, **13**, No. 12, 1937). The semi-enclosed bodies of water are shown to support a much larger number of copepods than do the open reefs and a large number of animals feed upon the copepods. The author describes the feeding habits of *Eleutheria*, or creeping medusa, abundant among *Ulva* and other seaweeds on the shores of Oahu. "These minute medusæ may be seen ingesting copepods as large as themselves, becoming greatly distorted in the process, and at the same time holding two or three other copepods within the grasp of their tentacles." It is found that shoal water copepods are more resistant to falling than to rising temperatures. A large proportion survive 5° C. for 17 hours, but all die in 16½ hours at 35° C. Dilute sea water in the proportion of 1 part sea water to 3 parts fresh water has no detrimental effect on copepods during a period of 48 hours. Many copepods survive a reduction in *p*H from 8·6 to 5·8 for 24 hours, a few for 48 hours, none for 72 hours. Adult specimens are more sensitive than larval forms to altered ecological conditions.

Lichens from Greenland

THE lichens collected by Prof. Theodor M. Fries (largely crustaceous) in 1871, supplemented by the collections of Dr. Johannes Grøntved (mainly macro-Lichenes) and others have been examined and collected into one volume by B. Lynge of Oslo. This volume must represent a very comprehensive survey of present-day knowledge of Greenland lichens, especially of the region of and around the Island of Disko. This region was visited primarily by the 1871 expedition to bring to Sweden some blocks of iron, detected the previous year by A. E. Nordenskiöld; these were formerly thought to be of meteoric origin, but were later proved to be telluric. (Meddelelser om Grønland. Bd. 118. No. 8. 1937.) The collections of Fries, gathered under the forced conditions of an Arctic expedition, were found to be in remarkably good preservation, though some difficulties were experienced with regard to dates and exact localities. Many of the lichens were difficult to photograph, and a method, new to lichenology, was used to throw the surface details into sharper relief. The lichen is suffused with the vapours of a white and very fine-grained ammonium salt. Temporarily the colour contrasts of disk and thallus are masked, but afterwards the covering salt evaporates and no damage is done to the plant. Use was also made of Prof. Asahina's new reagent paraphenylenediamin, which in many genera was found to be of great value for specific distinctions.

Peculiar Cystoliths in the Cucurbitaceæ

DR. H. L. CHAKRAVARTY'S paper upon the physiological anatomy of the leaves of Cucurbitaceæ (*Philippine J. Sci.*, **63**, No. 4, August 1937) seems to require a revision of the accepted ideas of those peculiar aggregates of calcium carbonate known usually as cystoliths. In the genus *Momordica*, and particularly in *M. cochinchinensis*, such irregular deposits of calcium carbonate are very common in enormously enlarged epidermal cells. In *M. charantia* the cellulose peg upon which the deposits are formed is very short, but in *M. cochinchinensis* the cystoliths have no definite structure. They are very irregularly branched, and the calcium carbonate strongly impregnates a stratified, branched cellulose skeleton. Their frequency is remarkable—in a square centimetre of leaf 1,000–1,600; in an entire leaf there may be as many as 100,000; so that enormous quantities of calcium carbonate must be accumulated in a single plant. The author directs attention to the fact that Zimmerman has described a similar type of cystolith in *M. rostrata* Zimmerman.

Endophytic Fungi of Rye-Grass

A FUNGUS which has hitherto defied identification is commonly distributed freely throughout most tissues of rye-grass, *Lolium perenne*. It has sometimes been regarded as a stage in the life-history of *Epichlœ typhina*, but Miss Kathleen Sampson shows, in a recent paper (*Trans. Brit. Mycol. Soc.*, **21**, Pts. 1 and 2, 84, Oct. 1937), that it has few characters in common with this fungus. The endophyte has been isolated upon egg medium, and cultured afterwards upon agar media, but no further clue to its identity has thereby been revealed. A second fungus has been isolated, which grows readily upon many kinds of media, and which is no less systemic than the first. It produces spiral hyphæ and microconidia, but provides no reliable diagnostic features.

Crustal Deformations around Lake Biwa

LAKE BIWA is the largest lake in Japan, its length from north to south being thirty-seven miles, and its average width nine miles. Along its shoreline are distributed no fewer than thirty-six water-gauges, and, from their records, Prof. C. Tsuboi (*Earthq. Res. Inst. Bull.*, 15, 935–942; 1937) has calculated the mean annual height of the surface at each station from 1887 until 1929. While there are many fluctuations in level, due probably to variations of rainfall, the mean annual height at all the stations shows that the level is falling at the rate of 5 ft. per century, and it is interesting to note that well-developed terraces occur at a height of about 650 ft. above the present surface. At one of the stations at the south end of the lake, the curve of mean annual height indicates a fall in level of about 6 in. during the years mentioned; while at another at the north end there was a rise of about the same amount. This suggests that the crust around the lake has been tilted towards the north by about 0·7 second of arc, and repeated series of levels along both sides of the lake agree nearly with this estimate.

Effects of Intensive Drying

SINCE H. B. Baker from 1912 reported rises in boiling point, surface tension and freezing point in the case of liquids intensively dried by phosphorus pentoxide, the problem has been investigated by others, who have mostly either failed to observe any change in physical properties or have explained the effects as due to superheating. D. A. Lacoss and A. W. C. Menzies (*J. Amer. Chem. Soc.*, 59, 2676; 1937) now find that when purified benzene is desiccated with purified phosphorus pentoxide with precautions to exclude or destroy dust, its vapour pressure, near 80°, is lowered markedly if the drying process is carried on at room temperature, but raised slightly if the drying is carried on at 90° or 105°. Without opening the sealed apparatus, the vapour pressure could be caused to revert to the normal value by heating the liquid out of contact with the phosphorus pentoxide, provided the desiccation had not been too vigorous. On allowing access of normal air, vapour pressures likewise reverted to the normal value. No change in vapour pressure was found in the case of benzene if the materials used were not both purified and also dust-free, nor when barium oxide or magnesium perchlorate were used as desiccants. Carbon tetrachloride, normal heptane and cyclohexane failed to show any change of vapour pressure upon desiccation under the same conditions as had given positive results with benzene.

Raman Effect and Analysis

AN interesting review of the application of the Raman effect to the analysis of organic mixtures by J. Goubeau appears in a recent issue of *Angewandte Chemie* (51, 11; 1938). The author points out the suitability of the method for the analysis of substances with non-polar linkages, and most organic substances fall into this class. The spectrum being determined by the actual structure of the molecule is capable of distinguishing between all types of structural isomerides. Optical isomerides and their racemates give the same spectrum. The application of the Raman spectrum to qualitative analysis is discussed, and the sensitivity of the method is considered. The applications of the method to typical analytical problems are then mentioned. The process has been used to detect impurities in substances, for example, the presence of secondary butyl alcohol in fermentation propyl alcohol, methyl bromide in ethyl bromide, and methyl alcohol in ethyl alcohol. The identification of substances by this method has the advantage over the determination of melting point or boiling point that the substance is not affected by the process. The existence of characteristic lines for different groups of atoms (C : C, C ⋮ C, C : O, etc.) makes it possible to classify a substance. The use of the method when dealing with mixtures of substances difficult to identify in other ways is described, the work of Dupont on the terpenes being mentioned. *Cis-* and *trans*-isoeugenol have been detected in the presence of each other. Mixtures of hydrocarbons have also been investigated. Quantitative analysis is also possible by determining the intensities of characteristic lines of the substance.

Reduction of Occultations for Faint Stars

In a recently published paper (*J. Brit. Astro. Assoc.*, 48, 3, January 1938) by Dr. M. Davidson an entirely new method is developed for the reduction of occultations. Instead of using the ordinary Besselian geometry, Dr. Davidson employs rectangular equatorial co-ordinates and shows how very accurate results are attainable. The method is applicable to stars of all magnitudes, but as the Nautical Almanac Office has computed certain constants for occultation stars brighter than magnitude 7·5, it is not suggested that the method should be used for these. The author hints at the possibility of taking into consideration the inequalities of the limb of the moon, thus greatly enhancing the value of a single occultation, and shows how this might be done, but admits the great difficulties in the practical application.

Interpretation of ε Aurigæ

THE paper on ε Aurigæ by Kuiper, Struve, and Strömgren, referred to in NATURE of January 22, p. 154, is now published (*Astrophys. J.*, 86, 570), giving full details of the latest theory regarding this most interesting binary star. The following is a short summary of the system as postulated by the authors: The principal component, the so-called 'infra-red star' (*I* star), has a temperature of only 1,200°–1,400° and contributes no appreciable light in the spectral region covered by the observations. It has a very great diameter (about one third of the major diameter of the orbit) so that the outer layers of its atmosphere are as near to the second component as to the centre of the *I* star itself, and are subject to greater influence from this source. This second component, an *F2* star of much smaller diameter, is the source of the observed spectrum as well as of the visible light from the system, and by photoelectric action of its ultra-violet radiation produces a shell of highly ionized material in the outermost layers of the *I* star. This shell is semi-transparent, and during the eclipse of the *F2* star (which is of 'grazing' character, not central) absorbs about half the light of the latter in a non-selective manner, thus explaining the observed constant minimum of the light curve and the similarity of the spectrum throughout. In the words of one of the authors, we are presented with "a new astronomical phenomenon, an eclipse by a stellar Heaviside layer".

Science in India*

PROGRESS OF ZOOLOGY

Zoology and its advancement in India were chosen by Prof. G. Matthai as the subject of his presidential address before the Section of Zoology. The address dealt with the progress of zoology since the foundation of the Indian Science Congress in 1914, and more particularly with advances made since 1921.

Oceanographical investigation of the Indian Ocean has been conducted, since the first meeting of the Indian Science Congress, mainly by R.I.M.S. *Investigator* (until 1926) and the John Murray Expedition (1933–34), under the direction of Lieut.-Colonel Seymour Sewell. Previously the *Sealark* Expedition, under the leadership of Prof. J. Stanley Gardiner, had surveyed the western Indian Ocean south of the Maldives, more particularly the islands of the Chagos Archipelago and the Mascarene region (during 1905–6 and 1908–9). The work of the *Sealark* Expedition was mainly on problems relating to coral reefs and atolls and their biology, and was a continuation of a previous study of the Maldives and Laccadives. The R.I.M.S. *Investigator* concentrated its work in the Andaman Sea and the Bay of Bengal. The recent work of the John Murray Expedition was in the region of the Arabian Sea not covered by the *Sealark* Expedition. The study of the deep-sea biology of this region was assisted by physical, chemical, hydrographic and topographic investigations. The Survey of India collaborated with the John Murray Expedition in the cruise down the Maldives for making pendulum observations with the view of determining the nature of the foundations on which the Maldives and Laccadives are situated.

The work of the R.I.M.S. *Investigator* has extended our knowledge in regard to variation in the air temperature over the open waters of the Indian seas, in the wind force, in the amount of rainfall and in the relationship between the temperature of the sea surface and that of the air. There is always a vertical circulation of the layers of water caused largely by differences in temperature and salinity. A reversal of seasons is noticeable in the Indian seas at a depth of about 100 fathoms, comparable to the phenomenon that takes place in the temperate seas.

The 'Murray Ridge' discovered by the John Murray Expedition appears to be ultimately connected with the Carlsberg Ridge. The latter ridge divides the western region of the Indian Ocean into north-eastern and south-western halves. 'King Fuad Bank' is probably a submerged atoll with a distinct rim about 40 ft. high and a level floor 130 fathoms deep.

Regarding the reefs of the Western Indian Ocean, Prof. J. Stanley Gardiner recently pointed out that the Mascarene Region differs from the Chagos Archipelago in regard to conditions of reef-growth, changes adverse to reef-growth taking place at a much higher rate than in the latter. The regression of coral reefs in the Mascarene region does not appear to be due to any biological reason such as sedentary organisms that cause destruction by boring into the reefs, since the activity of such organisms is decreased at the depths at which reefs of this region are situated, or by sediment, which cannot settle on the seaward sides of reefs and banks, or by precipitation of calcium carbonate (for such precipitation is not visible on coral polyps on the seaward sides), or by currents the action of which is less on the sides facing the sea, or by temperature, which at 30 fathoms is not lower than 61·9° F., or by any decrease in the amount of plankton that serve as food material to coral polyps, for it is not liable to much quantitative variation in the Indian Ocean; nor does the chemical composition of the surface water in the Indian seas show any appreciable difference. The comparative poverty of the deep sea fauna in the Chagos and Mascarene regions is perhaps due to the hardness of the sea floor and to the fact that the quantity of plankton which serves as food material to the larger organisms is less in the Indian seas than in the temperate regions. In spite of the "shallow and fierce conditions" of life on the reefs of these regions, it is interesting to observe that the animals do not exhibit any special structural features that may be regarded as adaptations to the peculiar environmental conditions.

The madreporarian corals collected by Prof. J. Stanley Gardiner in his several expeditions to the Indian Ocean, particularly of the astraeid corals, provided material for a comparative study, of the morphological organization of their hard and soft parts, with the view of determining, if possible, the limits of species and genera, most previous taxonomic studies on corals having been based on characters taken solely from the hard parts that are liable to considerable variation. The same material, along with others, formed the basis for a study of colony-formation in astraeid corals.

The Zoological Survey of India has been engaged mainly in faunistic investigation, more especially of the brackish water of the Chilka Lake and its island (Barkuda), the estuarine fauna of Goa, the fauna of the Mutlah River, of the Inle Lake, the Indian freshwater molluscs and their trematode parasites, the aquatic and terrestrial fauna of the Punjab Salt Range, the cave fauna of the Siju Cave in Assam. Particular attention has been paid to the study of the fishes of hill streams in various parts of India and their structural and other adaptations to this peculiar environment. Fisheries research, especially on *Trochus*, has been conducted in the Andamans.

The address ends with a brief account of the research work carried out in the various zoology departments in India.

ENTOMOLOGY IN INDIA

The past, present and future of entomology in India formed the subject of Mr. M. Afzal Husain's presidential address to the Section of Entomology.

Linnæus (1758) included in his "Systema Naturæ" twelve species of Indian insects, and thirty years later Fabricius (1792–98) included in his "Entomologia systematica" one thousand Indian species, collected mostly by the Christian missionaries. During the last hundred and fifty years insects have received much attention. The number of the existing species of insects in India cannot be less than 2·5 millions, but only one in sixty is known. The

* *Continued from page* 297.

condition of Indian insect collections is also very unsatisfactory. It is distressing to find that most of the 'types' of Indian insects have gone out of the country. In the museums there is scarcely one 'type' for every hundred species described.

The Indian Museum laid the foundation of agricultural entomology in 1884 and the Imperial Institute of Agricultural Research at Pusa and the Agricultural Departments in the provinces and some Indian States have carried on the work. The Indian Central Cotton Committee, the Imperial Council of Agricultural Research, the Indian Tea Association and the Indian Lac Association have fostered the study of the insects of agricultural importance. Similarly, the small band of workers in forest entomology have achieved much success.

Ronald Ross and the workers who followed him made most valuable contributions to medical entomology, which have been of utmost utility to humanity. The Indian Research Fund Association has financed much research on insects of medical importance. Veterinary entomology has been greatly ignored, and it is only lately that an entomologist has been appointed to study insect pests of domesticated animals. In education, entomology has long been the Cinderella among sciences. Even in agricultural colleges it is only within the last few years that entomological teaching has received some attention. In most medical and veterinary colleges, entomology has no place in the curricula.

India is equally behind in entomological literature. There is no literature on insects in any of the vernaculars of India. The "Fauna of British India" is not developing as fast as one would wish it to develop. There are few catalogues of insect groups.

According to Sir Thomas Holland, among the sciences of economic value entomology perhaps ranks first in importance to India. Sir Mirza Ismail has drawn a very gloomy picture of the conditions in India. More than one hundred million people suffer from malaria every year and more than one million succumb to its effects. "The debility, poverty and apathy caused by this disease are factors of magnitude in retarding the national, social and economic progress of the country". *Anopheles* brought about the decay of the Greek and Roman civilizations, and is to-day one of the major obstacles to progress in India. According to Fletcher, the sugar-cane pests alone cause an annual loss of 300,000,000 rupees. The hide industry of India suffers a yearly loss of 1·5 crores of rupees from one insect—ox warble fly. At a very modest computation, the annual loss caused to India by insects has been put at 200 crores of rupees, and a loss of more than a million and a half of human lives. It is a truism that insects have been responsible for more destruction of property and loss of life than that caused by all the wars, floods, earthquakes, fires and famines in human history, and the losses caused by them are on the increase. Advancing civilization is producing conditions most suitable for insect multiplication and spread.

The tribute of Rs. 200 crores which India pays to the demons *Satpada* is a heavy drain, which should not be permitted to continue. An effective defence against these enemies will reduce this enormous wastage, and India will have enough money for her national development. To effect this, an army of workers must be produced to study insect life in all its aspects, and an army well equipped with knowledge and machinery to fight these demons. The public must be made to appreciate the importance of insect study. Entomology must take its place in the schools and universities, agricultural, medical and veterinary colleges. Funds should be provided to develop pure and applied entomology. India has depended far too long on the generous assistance of foreign workers and institutions for the progress of Indian entomology, but the time has come when she must shoulder her own burden. In every province and every State, insect surveys should be conducted, museums for insect collections and insect study established, Indian universities should come forward to take their full share in entomological development. An Entomological Society of India and an entomological journal are also needed.

Racial Composition of the Hindukush Tribes

Dr. B. S. Guha in his presidential address to the Anthropological Section discussed the racial composition of the Hindukush tribes.

The region south of the Hindukush and Karakorum Mountains occupies a strategic position in the racial geography of India, for in these difficult, high mountainous valleys are still sheltered some of the remnants of the northern steppe folk who invaded India in the second millennium B.C.

Linguistically the tribes living in this area can be classified under two heads, namely, Dardic and Burushaski, with Kaffiri occupying an intermediate position between Iranian and Indian. Burushaski is unrelated to any known language; but Morgenstierne's investigations have shown the essentially Indian character of the Dardic and even the Kaffiri languages.

The earliest investigations on the somatic characters of these interesting tribes were those of Ujfalvy, followed by Stein, Dainelli and B. S. Guha, who, as a member of the scientific expedition sent by the Government of India, visited Kaffristan and Chitral in 1929.

From a careful consideration of physical characters, it appears that the basic racial type in the entire region is a short, dark dolichocephalic strain with prominent long nose, often aquiline, which might be regarded as a variant of Eugen Fischer's *Oriental race* and the most characteristic type of the region.

Besides this principal type, there is the southern extension of a broad-headed race closely allied to what is known as the *Dinaric race* of eastern Europe. In its strongest form it is found among the Khos of the Chitral valley and the Burushos of Hunza Nagir, though it occurs throughout the Dardic tribes in varying degrees. The skin colour in this race is prevailingly of a rosy white tint, but the eyes are more often hazel and green, and the colour of the hair is brown.

The third main racial strain is a tall dolichocephalic type with long and straight nose. It forms a very important layer among the Kaffir and the upper stratum of the Burusho and the Dardic tribes. The distribution of the cephalic index in this type follows the same trend as found by Ariens Kappers in the races of the Aral Caspian regions and very similar to that which forms the dominant element in the northern European population, from whom its chief distinction lies in the integumentary colours. Whereas in Sweden the blond type represents 49 per cent of the population, among the Kaffirs it does not exceed 15 per cent. Blondness, as is well known, is due to a deficiency mutation which suppresses the appearance of pigment. It is certain that this

deficiency mutation has occurred in this and at least in another, namely, the *East-Baltic race*, at some time or other. It is probable that the mutations for skin, hair and eye colours have taken place separately. In the Baltic tribes, the high rate of the deficiency mutation might probably account for the larger percentage of the blond as compared to the Hindu-kush tribes, among whom the activators are perhaps dominant over suppression, causing the general persistence of the more pigmented people.

Lastly, an intruding Mongoloid element must also be responsible for the yellowish tint in the skin colour and broad flat nose found among many individuals.

The proportions of these strains vary in different parts. The Dinaric and the Proto-Nordic elements are stronger in the western valleys, whereas the basic Oriental and the Mongoloid elements are more conspicuous in the eastern valleys of the Upper Indus.

BREEDING INVESTIGATIONS IN THE SUGAR-CANE

Hybridization in and with the genus *Saccharum* formed the topic of Rao Bahadur T. S. Venkatraman's presidential address to the Section of Agriculture. Hybridization in the sugar-cane at the Imperial Sugar-cane Station at Coimbatore represents the first attempt to improve the subtropical types of canes. This genetical work, which has been going on at the Station for more than twenty-five years, has involved six species of *Saccharum* and four genera. There appear to be two distinct groups of wild species of *Saccharum*, both of which are confined to south-east Asia. Some of the wild species show wide variations. For example, a survey of the Indian wild species, *S. spontaneum*, showed a variation in sugar content of the juice from 0·5 per cent to 17·0 per cent, the latter figure being higher than that of certain cultivated Indian canes.

The Indian canes belonging to the species *S. barberi* are cultivated in subtropical India, though some are found farther south. Certain Indian canes cannot be ascribed to the genus *Saccharum*, the most important being the Mungo group of Dr. Barber.

A wide range of forms is known to arise from sugar-cane seed. This is explained by the heterozygous nature of the parents and the fact that most sugar-canes in cultivation are polyploid; for example, *S. offinarum* is octoploid.

Very little in-breeding has taken place in the sugar-cane, but much work has been done on inter-varietal, inter-specific and even inter-generic hybridization. Inter-varietal hybridization has been confined mostly to *S. officinarum*. At Coimbatore, economically important inter-specific hybrids have been obtained from *S. officinarum* × *S. spontaneum*. In Australia and Hawaii, *S. robustum* is being used for producing hardier seedlings for tropical regions.

At Coimbatore, inter-generic hybridization has been carried out, using such genera as *Sorghum* and *Bambusa*. The *Sorghum* cross was introduced to produce a shorter life-cycle which in the sugar-cane is from twelve to even twenty-four months. Hybrids producing a crop in seven months have been produced, and these have had high quality juices. Growth vigour in these, however, has proved disappointing. Crossing with the bamboo (*Bambusa*) has been introduced in order to obtain greater vigour, but experimental work has not proceeded far enough yet to justify definite conclusions, from the economic point of view.

The previously mentioned inter-generic hybrids have shown some interesting phenomena with regard to the manner in which the characters are shown in the F_1 generation and transmitted in further back-crosses with either parent. In both the *Sorghum* and *Bambusa* hybrids with sugar-cane, the one fact that stands out prominently is the general dominance of *Saccharum* characters in the F_1 generation.

In the case of *Saccharum* × *Sorghum* hybrids, the general dominance of *Saccharum* characters was found to persist even after twice back-crossing the hybrids with their *Sorghum* parent. Certain of the *Sorghum* hybrids exhibited morphological characters not found in either parent. Most of these hybrids were infertile in their first generation. On further vegetative propagation, however, some of them are showing an increasing fertility in the sexual organs with the result that, whereas in the earlier years no seeds could be obtained from these, it has since been possible to raise seedlings in large numbers from some of them and also to back-cross them with the two parents.

[*To be continued.*]

The Prehistoric People of Palestine*

By Sir Arthur Keith, F.R.S.

THE fossil remains of the earliest inhabitants of Palestine were discovered in caves of Mount Carmel by an expedition led by Miss Dorothy Garrod, and financed by two societies—the British School of Archæology in Jerusalem and the American School of Prehistoric Research. The early Palestinians were quite unlike any people now living, but are of profound interest, because, if not our actual ancestors, they are certainly near akin to the human stock which in the course of time gave the world its Caucasian or white inhabitants. Hitherto our search for the fossil ancestor of the white man has been in vain. Everyone is familiar with the place held by Palestine in our conception of human life at the dawn of history; the excavations made at Mount Carmel by Miss Garrod are destined to give that small country in the East an equally important place in our picture of man's prehistoric world.

What the expedition found was this. Man began to inhabit the caves of Mount Carmel long before the onset of the last glaciation of Europe. One cave from an archæologist's point of view is the richest ever opened; it was filled with fossiliferous earth tramped down by the feet of prehistoric man, until an accumulation more than 80 feet in depth had been formed. From bottom to top the strata were

* Substance of a lecture given by Sir Arthur Keith at the Royal College of Surgeons on February 14.

pregnant with man's stone tools, with the fossil bones of animals—many of them of extinct species, and with the bones of the men and women who fashioned and used the tools. It is no exaggeration to say that these deposits record the history of man in Palestine for a period of at least 100,000 years; the period may be longer; the future is not likely to prove that it was shorter. The strata begin while man is still in an early stage of stone culture; they leave off about the time of Abraham. There is no need to tell how each stratum has been made a page of history; the story is told by Miss Dorothy Garrod and Miss Dorothea Bate in a volume just issued by the Oxford University Press [see p. 304 of this issue].

Hitherto we have had to build our knowledge of prehistoric man out of fossil scraps. At Mount Carmel complete skeletons were found; one small cave, excavated by Mr. T. D. McCown of the American School, proved to be a veritable cemetery; fossil remains of ten individuals were found in it—three of them complete skeletons—the others were disturbed burials. Altogether we know thirteen of the fossil Carmelites by name or number. We have become familiar with all of them. Four are children, all the adults are less than fifty years of age, save one. Only one had turned fifty at the time of death. The expectation of life was not good among these early inhabitants of Palestine.

We owe so complete a representation of this prehistoric community to certain circumstances: (1) the careful way in which the dead had been buried; (2) to the fact that Mount Carmel is composed of limestone, and limestone tends to the preservation of bones better than any other rock. If the limestone helped to preserve the Carmelite bones, it also made their extraction a matter of extreme difficulty. Mr. McCown, realizing the impossibility of removing the bones piecemeal in the cave, cut out the bone-containing breccia—hard as cement—in blocks weighing a ton or more, and had them conveyed from the slopes of Mount Carmel to the Museum of the Royal College of Surgeons in Lincoln's Inn Fields, London. The rougher work of extraction was done at the Museum but the finer work, including restoration, examination, comparison, drawing and photography of the various bones were done, by permission of the President and Council of the College of Surgeons, at the Buckston Browne Research Farm, Downe, where, within sight of Darwin's old home, Mr. McCown and I restored the old Palestinians to life—or as near to their living state as is now possible. Mr. McCown and I began our task in the autumn of 1933; the final account of what we had done and seen was drawn up for publication at the end of 1937. Thanks to Dr. J. Beattie, conservator of the Museum of the Royal College of Surgeons, our task was made easy.

What kind of people were those early dwellers on Mount Carmel? The Bible records in the book of Genesis that before the flood "there were giants in the land". The fossil people we are now dealing with are almost worthy of such a name. The men were tall; four of them range in height from 5 ft. 8 in. to 5 ft. 11 in. The women, on the other hand, were of short stature, varying from 5 ft. to 5 ft. 4 in. We have been able to study every bone of the feet, hands and limbs of this ancient people; they had straight and strong limbs, walking and running as we do, and yet every bone differs in detail from our bones. Their chests were ample; we infer they were runners and long-winded. We have studied their spinal columns; their vertebræ still retain certain simian details in their conformation. It is so with the bones of their hands and arms; in certain points they are peculiar. We have been able to measure their heads and in some cases to take casts of their skull cavities and thus obtain a crude picture of the conformation of their brains. Although the fossil men of Mount Carmel are separated from us in time by the space of a whole glacial epoch, yet in point of size they had already brains which were equal to ours, although as regards convolutionary pattern, theirs were the simpler. The muscles of their tongues were attached to their lower jaws as ours are; all the parts of the brain which indicate a capacity for speech were present.

In their anatomy they still retained many primitive marks. Their eyebrow ridges, like those of the gorilla, form great bars of bone above the orbits; their jaws are massive; their mouth cavities were very much more capacious than ours. Their necks were thick and exceedingly strong.

Nowhere in the world of to-day could there be found a local group of people showing the wide range of structural variation of our fossil Palestinians. Chins were at every stage of evolution—from a chinless stage comparable to that of the chimpanzee, to chins of moderate development. One of the most distinctive of human features is the nose; in nose-form, the Palestinians were not uniform; in one the size of the bridge and general prominence might well be the prototype of the Roman nose; in another, an opposite condition—almost negroid—prevailed. We found it possible to arrange the individuals of the group in a series; at one end, a woman had her closest affinities to the very primitive Neanderthal type of Europe; at the other end of the series, a man known to us as Skhūl IV might be a crude form of an early European. We seem to be dealing at Mount Carmel with a plastic folk in the throes of evolutionary change.

To fit the fossil Palestinians into their place in our picture of ancient humanity we have to think geographically. We now know that before the last glacial epoch set in, Europe was inhabited solely by peoples of the Neanderthal type; their fossil remains have been found as far west as the Island of Jersey and as far East as the Crimea. As we go eastwards, the type approximates somewhat to that which we have now found in Palestine. In Mount Carmel we have a people whose date is earlier, not later than that of the Neanderthalians of Europe. Our Mount Carmel people have many points of resemblance to the Neanderthalians of Europe, and yet in many they differ. In those points wherein the Palestinians differ from the Neanderthalians, they are Caucasian or modern.

Have we, then, reached the homeland of Europeans in Palestine—the Eden in which Neanderthal man evolved into man of the modern type? That is not the inference Mr. McCown and I are inclined to draw; we believe that, as research is carried further into Western Asia, we shall find the fossil remains of men who have still less of the Neanderthalians in them and more of us moderns than is the case at Mount Carmel.

The first glimpse we have in Europe of the early Caucasians or 'whites' is obtained when the crisis of the last glaciation was passing. They then appear in South Europe as Cromagnons and in central Europe as Predmostians. Hitherto we did not know whence these early representatives of our type had come. The discovery at Mount Carmel suggests that

we shall find their homeland in Western Asia. Our tall men of Mount Carmel have many structural points in common with the tall Cromagnon. History, it is said, repeats itself; the Cromagnons blazed the trail from Asia to Europe; the ancient Palestinians may not be the ancestors of the Cromagnons but only distant relatives; at a much later date, Western Asia gave Europe its forms of speech and also, we presume, the primitive speakers of the Aryan tongue.

The most surprising result of the excavation of the caves of Mount Carmel is the light thrown on the mentality of early stone-age mankind. Care of the dead is one of the hall-marks of humanity. The Mount Carmel people had a care for their dead. The youngest child was placed in its grave in a sitting position with limbs flexed under the trunk and arms folded. The tallest of the men had in his embrace the fossil jaw of a boar; we do not suppose it was in a fossil state when placed in his dead arms; we suppose it carried with it a meal of which he had been fond—a pig's tongue. We must also suppose that those who placed the supply of food in the grave beside him believed that death was not the end of life. Even thus early man seems to have softened the blow of death with a hope of immortality.

Another very unexpected discovery was this. When the hip joint of one of the men was cleared of limestone breccia, it was found to be shivered. On closer examination a perforation was found at the centre of the injury, filled in with cave earth. When the earth was removed from the perforation of femur and pelvis and a cast taken of it, we had before us the image of a four-side spear-head. We did not know that such weapons had been invented at so early a date; we believed that the only fighting weapons possessed by men then were stone clubs. A spear to penetrate the whole thickness of the hip joint of a large-framed man and to enter the pelvis as this weapon did must have been finely tempered and driven with exceeding force.

Science News a Century Ago

Solidification of Carbonic Acid

QUOTING from the *Scotsman*, the *Mechanics' Magazine* of February 24, 1838, said: "Mr. Kemp, of Edinburgh, who has been so successful in his experiments upon the liquefaction of the gases, has succeeded in reducing carbonic acid gas to the solid state. This experiment, which had been previously shown in Dr. Hope's class-room, Mr. Kemp exhibited before the Wernerian Society at their last meeting, in the presence of Professors Jameson, Forbes, Graham, Trail, Welsh, Pillans, Dr. Neill, and a number of other scientific gentlemen. The gas requires a pressure of thirty-six atmospheres to reduce it to the liquid form. When the pressure was removed by opening a small stopcock on the condensing apparatus, the cold, produced by the rapid evaporation of the liquid, was so great, that the whole mass was almost instantly reduced to the solid state; and in this condition, although the temperature could not have been less than 180 degrees below zero Fahrenheit, it was handled and tasted by many of the gentlemen present. . . . This is the first time that the solidification of carbonic acid has been accomplished in Great Britain. Many important results may be expected to accrue from it . . . there can be no doubt, that any liquid may be frozen by it, and it will be a powerful agent in producing the condensation of those gases which have hitherto resisted all attempts to reduce them to their liquid form."

Kenneth Kemp, who for some years assisted the professor of chemistry, Thomas Charles Hope (1766–1844), died in 1843 at the early age of thirty-six years.

Reform of the Patent Law

IN the issue of *The Railway Magazine and Annals of Science* of February 1838, is a contribution by Mr. J. Hacket entitled "Suggestions on a New System of Granting Patents for Inventions". After a brief review of the Patent Law at that time and the disabilities inventors suffered from and the loss to society through the discouraging effects of the system which then prevailed, the writer went on to say that nothing short of a new system based upon a new principle was required. "The only measure that I can conceive," he said, "calculated to produce the beneficial effects so much required, is a national institution, in which are a number of suitable apartments, with models, plans and specifications of the most useful machines, manufactures, etc., now in use, patented and unpatented, classed in proper order—over each department in the proposed national establishment, persons suitably qualified should be appointed to arrange in order, protect from injury, and be accountable for every model, plan and specification committed to their charge." Individuals desirous of obtaining a patent were to send notice to the secretary of the institution and, on the receipt of the plans and specifications and a fee of £1, protection was to be obtained for one year. At the expiration of this year, or the patent being put into operation, £5 annually was to be paid.

Wind Measurements at Birmingham

IN a letter published in the *Athenæum* of February 24, 1838, Mr. William Ick, the curator of the Birmingham Philosophical Institution, gave some observations made with a self-recording anemometer and a rain gauge. In a violent gale on December 18, 1837, he said, which continued without intermission for 14 hours, the anemometer registered the highest force of the wind as 16½ pounds on the square foot. This gale was exceeded on December 20 when the highest pressure recorded was 21¼ pounds. Other records were taken on January 2 and February 9, 12 and 15 of 1838. "I shall offer no comments on these facts," he added. "The British Association have voted a sum for the erection of an anemometer at Plymouth, and Mr. Osler has very nearly completed the instrument. If another were erected in the northern part of the island, and several others in distant stations judiciously chosen, in the continents of Europe and America, a comparison of the results might in a few years furnish important information respecting the laws which regulate the force and direction of aerial currents and their influence on temperature, humidity, etc."

The inventor of the anemometer to which Mr. Ick referred was Abraham Follet Osler, who was born in Birmingham on March 22, 1808, and succeeded to the glass-making business of his father, which he carried on until 1876. His self-registering meteorological instruments were installed at Greenwich and elsewhere. He was elected fellow of the Royal Society in 1855 and died at Edgbaston on April 26, 1903.

Societies and Academies

Edinburgh

Royal Society, January 10.

A. B. WILDMAN and J. MANBY: The hairs of the Monotremata, with special reference to their cuticular scale pattern. An improved technique for the examination of cuticular scale margins is described and the sequences of scale form along the fibres are discussed and demonstrated photographically. The sequence on the shield-hair of *Ornithorhynchus* is unique and in this, as in other characteristics, the shield possesses a marked bilateral symmetry. Those tail fibres, which possess no shaft portion, correspond to the shields of the more typical shield-fibres. Support is given to the view that the shields constitute a remnant of a more primitive spinous coat. The authors indicate that changes in scale-form along the fibre are innate and are not caused by attrition.

A. GRAHAM: The structure and function of the alimentary canal of æolid molluscs, with a discussion on their nematocysts. The anatomy, histology and physiology of the alimentary tract of four species of æolid molluscs are described. The digestive gland secretes enzymes, digestion occurs in its ducts and in the stomach. Soluble food is absorbed in these positions and in the gland where particles of food are also ingested. Mucus from buccal and pedal glands secreted over the food appears to prevent the discharge of nematocysts; those stored in the cerata are exploded by mechanical means.

MARY G. CALDER: Some undescribed species from the Lower Carboniferous flora of Berwickshire; together with a note on the genus *Stenomyelon* Kidston. Two new species of petrified seeds are described: *Calymmatotheca kidstoni* is a radiospermic, cupulate seed, and *Samaropsis scotica* is a platyspermic, winged seed. *Kalymma tuediana* n.sp., a petiole probably allied to *Calamopitys*, is also described. The species *Stenomyelon tripartitum* Kidston is shown to be synonymous with *S. tuedianum* Kidston. The descriptions are based upon material from the Calciferous Sandstone Series (Cementstone Group) at various localities in Berwickshire; the material is now in the Kidston Collection in the Botany Department of the University of Glasgow.

H. MERTON: Studies on reproduction in the albino mouse. (1) The period of gestation and the time of parturition. With the help of a self-recording balance, constructed after the principle of a letter-scale and connected with a kymograph, the hour of parturition can be fairly accurately determined. Two-thirds of the births took place between 4 p.m. and 4 a.m. Of 90 females, 84 were fertilized within 4 days after being placed with a male: they therefore showed a very regular cycle of 4–5 days. The methods are described which can be used to predict the day of birth. The average size of 504 recorded litters during the year was 7·0, the largest (8·3) occurring in August.

Paris

Academy of Sciences, December 27 (*C.R.*, 205, 1333–1476)*.

MME. LÉONE WALTER-LÉVY: Neutral magnesium chlorocarbonate.

ALEXANDRE TRAVERS and HAMID ZAHABI: The preparation of the hexahydrate of tricalcium aluminate.

**Continued from p. 300.*

MME. PAULINE RAMART-LUCAS: The structure and absorption of colouring matters. Isomeric forms of fluorescine.

MARC TIFFENEAU and BIANCA TCHOUBAR: The removal of halogen by silver from the iodhydrines of the α-cyclanediols.

MME. YVONNE KHOUVINE and YOSHINORI TOMODA: The total acetylation and methylation of α-*d*-tagatose.

HENRY GAULT and JEAN BURKHARD: A partial synthesis of methyl-cyclopentenolone from wood tar.

DANIEL BODROUX and RENÉ THOMASSIN: Syntheses effected with *p*-cyclohexylbenzyl chloride.

LOUIS ROYER: The orientation of certain alkaline halides by calcite.

JEAN GUBLER: The structural and palæogeographical unities between Fez and Le Sebou (Northern Morocco).

GEORGES CHOUBERT: The Lias of the eastern Haut-Atlas and of the Hauts-Plateaux.

JEAN SAGATZKY: The Tarkwaïen system in Ex-Haute-Volta.

RAYMOND JOUAUST, ROBERT BUREAU and LOUIS EBLÉ: The sudden disappearance of radio-electric waves, their relations with magnetic and solar phenomena. From a study of a year's data, it is concluded that chromospheric eruptions cause sudden disappearance of radio-electric waves and, at the same time, small local magnetic disturbances are produced, the latter differing from magnetic storms.

PIERRE DANGEARD: The presence of pyrenoids in some species of *Vaucheria*.

JACQUES RABATÉ and JEAN DUSSY: A new holodiglucoside extracted from sophoraflavonoloside.

VICTOR PLOUVIER: The presence of amygdonitril-glucoside in the genus *Cotoneaster* and some other Rosaceæ.

EMILE MIÈGE: The baking qualities of *Triticum*, of *Ægilops* and of their hybrids.

JOSEPH LEFÈVRE: Some effects observed as the result of the treatment of seeds and cuttings with various substances and especially with heteroauxin.

ANDRÉ HOLLANDE: Amœbæ of the limax type, in their relations with flagellates.

PIERRE DRACH: The origin of the limestone in the tegumentary skeleton of the crustacean Decapods.

DANIEL AUGER: The stimulation of an internode of *Nitella* by the current of action of a contiguous inter-node, latent addition.

MARIUS PIÉRY, JEAN ENSELME and MLLE. SIMONE PETEL: Researches concerning the influence of mineral waters on tissue respiration. The constitution of a system of research by means of Warburg's technique.

RAYMOND-HAMET: The physiological activity of pure gelsemine.

MLLE. MARIE THÉRÈSE REGNIER: The action of the sexual hormones on the inversion of sex in *Xiphophorus helleri*.

ALBERT RAYNAUD: The histological study of the genital tract of female mice transformed experimentally into free-martins.

JAQUES MONOD: Maintenance ration and growth ration in bacterial populations.

RENÉ CATALA: The influence of thermal agents on the nymphosis of the larvæ of *Chrysiridia madagascariensis*.

MME. NADINE DOBROVOLSKAIA-ZAVADSKAIA: The appearance of a new *culbute* mutation in two different strains of mice.

FRANÇOIS ARTIGAS: The absorption by thin screens of the radiation of potassium sulphate and of plant ashes.

GEORGES BROOKS: The determination of the fluorescence spectra of ash isolated from the tissues of *Rana esculenta*.

LAZARE SILBERSTEIN: The action of chloropicrin on the vitamin B_1 contained in wheat. Chloropicrin is increasingly used for the destruction of insects in cereals: experiments on pigeons show that vitamin B_1 in wheat is unaffected by this chemical.

MME. YVONNE JÉRÔME-LÉVY: The acetic fermentation in the presence of charcoal. In the presence of charcoal the production of acetic acid is accelerated, and the quantity produced is also higher.

AUGUSTE CUÉNOD and ROGER NATAF: The polymorphism of *Rickettsies* of the trachome.

ARTHUR VERNES, ROBERT BRICQ and MLLE. ANDRÉE GAGER: New considerations on the pallidine of syphilitic sera.

Calcutta

National Institute of Sciences of India, January 9.

SYMPOSIUM ON RIVER PHYSICS IN INDIA.

D. N. WADIA: Changes in the courses of Indian rivers during the latest geological epoch.

SUNDER LAL HORA: Changes in the drainage of India, as evidenced by the distribution of freshwater fishes.

C. C. INGLIS: The use of models for elucidating flow problems based on experience gained in carrying out model experiments at the Hydrodynamic Research Station, Poona.

GERALD LACEY: The flow of water in alluvial channels.

KANWAR SAIN: The effects of the construction of weirs and weir-controlled canals on the regimes of the Punjab rivers.

A. N. KHOSLA: Design of weirs on permeable foundations.

N. K. BOSE: River physics laboratories of Europe and America.

S. C. MAJUMDAR: River problems in Bengal.

P. C. MAHALANOBIS: River floods in Orissa.

Cracow

Polish Academy of Science and Letters, December 6.

MLLE. L. STANKIEWICZ: The arithmetical operations in the numerical solution of a system of linear equations according to the methods of Banachiewicz.

W. SWIETOSLAWSKI, L. KEFFLER and J. SALCEWICZ: Contribution to the study of the quantity of heat evolved in the internal transformation of a block of lead produced by the action of its own weight. The authors prove the existence of a thermal effect of the order of $0{\cdot}4 \times 10^{-4}$ to $0{\cdot}2 \times 10^{-4}$ calories per gram per hour. When massive blocks of lead are used for measuring the heat given off by radioactive elements, this phenomenon must be taken into account.

J. MOSZEW: Syntheses of compounds of the type 2′-phenyl-3′, 4′, 2, 3-quinolinoquinoline.

ST. KREUTZ: The metamorphosis of the amphibolite rocks of the Tatra.

L. CHROBAK: Pegmatites and granites containing molybdenite of the western Tatra.

J. WOJCIECHOWSKI and MLLE. L. SKROBINSKA: The action of the hydrogen ion concentration on the chemotropism produced by phosphates.

Forthcoming Events

[*Meeting marked with an asterisk is open to the public.*]

Monday, February 21

IMPERIAL COLLEGE OF SCIENCE (Chemistry Lecture Theatre), at 5.15.—Prof. W. P. Jorissen: "Reactions in Gaseous and Solid Mixtures".*

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A. Stephenson and the Rev. Lancelot Fleming: "King George the Sixth Sound".

Wednesday, February 23

SOCIETY FOR THE STUDY OF ALCHEMY AND EARLY CHEMISTRY, at 8.—R. B. Pilcher: "Alchemists' Apparatus in Art".

ROYAL SOCIETY OF ARTS, at 8.15.—Oscar Borer: "Reclamation of Tidal Lands".

Friday, February 25

ROYAL INSTITUTION, at 9.—Prof. D. M. S. Watson, F.R.S.: "Pterodactyls Past and Present".

ASSOCIATION OF TECHNICAL INSTITUTIONS, February 25-26.—Annual General Meeting to be held in the Haberdashers Hall, Gresham Street, London, E.C.2.

February 25, at 11 a.m.—Sir Robert Pickard, F.R.S.: Presidential Address.

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

LECTURER IN ENGINEERING in the East London Technical College, South Africa—The High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (March 4).

UNIVERSITY DEMONSTRATOR IN ENGINEERING—The Secretary of the Appointments Committee, Engineering Laboratory, Cambridge (March 9).

LECTURER IN ANATOMY in the University of Belfast—The Secretary.

Reports and other Publications

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Report of the Little Owl Food Inquiry, 1936–37. Organised by the British Trust for Ornithology. By Alice Hibbert-Ware. Pp. 74+8 plates. (London: H. F. and G. Witherby, Ltd.) 3*s.* 6*d.* net. [201

Leeds University. Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing during the Session 1936–37. Pp. 24. (Leeds: The University.) [201

University College of Wales, Aberystwyth. Leaflet Series S, No. 6: New Varieties and Strains from the Welsh Plant Breeding Station—Two New Varieties of Oats, S84, Spring Oats for Soils of High Productive Capacity; S175, Spring Oats for Soils of Medium Productive Capacity; and Notes relative to the Cultivation of Ceirch Liwyd Cwta (S171) and relative to the Selection of Varieties. Pp. 23+3 plates. (Aberystwyth: Welsh Plant Breeding Station.) 1*s.* [211

University of London: Institute of Education. The Teaching of Mathematics: a Bibliography. By Max Black. Pp. 14. (London: Christophers.) 6*d.* [254

Other Countries

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 17, 1935, vi. Aerologiska iakttagelser i Sverige, 1934–1935. Pp. 10. 3.00 kr. Meddelanden, Serien Uppsatser. No. 16: Luminous Efficiency of Solar Radiation. By T. E. Aurén. Pp. 24. 1.50 kr. Nr. 20: Några aktinometrars egenskaper med hänsyn til mätning av artificiell strålning i samband med växtodling. Av Gösta Köhler. Pp. 98. 3.00 kr. No. 21: Hydrologisk bibliografi åren 1935 och 1936, Sverige, Årgångar 2 och 3. Pp. 14. 1.00 kr. No. 23: Actinometric Measurements near Stockholm, 1930–1936. By Anders Ångström. Pp. 28. 2.00 kr. (Stockholm: Statens Meteorologisk-Hydrografiska Anstalt.) [211

Science and Reality. Pp. 28. (Calcutta: Science and Reality.) [251

Mitteilungen der Prähistorischen Kommission der Akademie der Wissenschaften. Band 3, Nr. 1–3: Untersuchungen im Bergbaugebiete Kelchalpe bei Kitzbühel, Tirol. Von Ernst Preuschen und Richard Pittioni. Pp. 160+39 plates. (Wien: Holder-Pichler-Tempsky A.G.) [251